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IRRIGATION:
Traditional vs Modern

by

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Abstract

In spite of the great progress made by modern works, traditional irrigation systems have still not lost their importance. Recently a renewed interest is observed all over the world in their technologies, environmental interaction and traditional management methods. The article introduces various types of indigenous irrigation works found all over India and compares their performance with those of the modern irrigation works. The paucity of information does not permit generalization in all aspects for the whole of the country. The first two sections relate to the whole of India and eventually, focus on environmental problems. The third section, intensive study of one state, complements the above with better understanding of the minor irrigation works and their problems. The fourth section introduces traditional management methods with a case study of one irrigation system. In a final section we have discussed future outlook and what lessons may still be obtained from studying traditional irrigation works.

Call me a 'revivalist' or whatever you like. I am still interested in traditional irrigation methods. Should one think of it there is ample reason to do so. After all what is the great distinction between traditional and modern irrigation? The first application of modern engineering technology to irrigation dates back to early nineteenth century. But that was nothing more than the revival of an age-old irrigation system in South India. And this is not the lone case. The great majority of the modern works undertaken in different parts of the world throughout the nineteenth century were either revival, or development or extension of traditional irrigation technologies which have existed sometimes for millenia. The only truely 'modern' work with no indigenous tradition behind was undertaken during the last century in U.S.A. Seen in this perspective it is not possible to deny that modern irrigation engineering has learnt a lot from many different old technologies found all over the world.

The contemporary importance of indigenous works arises from the fact that the process of learning by modern technology has not been complete. With its contempt for the old world modern engineering has rarely shown much interest to learn from them. Its euro-centric[1] orientation has been a stumbling factor even for proper appreciation of these works -- the West has never been dependent on irrigation for agriculture. And finally, many of the traditionally irrigated areas were colonies or semi-colonial countries still the other day. The arrogance of the colonial masters particularly to such aspects where the subjugated excells, was no less a reason for the negligence. The result is that even now ancient techniques of irrigation are being discovered by modern irrigation experts, those are being revived in many different parts of the world [Evenari, et.al., 1975]. But a far general area of interest is the traditional techniques of management from which valuable lessons may be learnt [Coward 1977]. Many modern projects have only

poor performance records because of bad management. It is worth noting that the well-known shortcomings of the irrigation projects in India are also observed in U.S.A., sometimes in more acute forms[2]. A third area of interest is their suitability to environments. There were, no doubt, mistakes and blunders even in the past. But then, only those which have passed the test of time, reach our generation. This is where the traditional systems rank far above the unscreened modern systems. The environmental implications of the former are well-known; their designs - both engineering and management - often perfected over long time.

Let us take a look at the irrigation geography of the world (Table-1). Though irrigation works are found almost everywhere, nowhere those are as important as in the monsoon Asia stretching from India to Japan. In fact most parts of the world do not need artificial irrigation for agriculture. In Asia however, because of the marked seasonality of rainfall, agriculture could develop only by being viable under wet conditions. Thus the course of development of agriculture has been different in West Europe and monsoon Asia [See Tamaki, 1977; Mukhia,1981; Bray, 1983]. The modern technology, which originated in the West was therefore, unable to appreciate the characteristic development pattern of Asia. To a people with a very different concept of development the agriculture in Asia appeared backward and stagnant. But equally inefficient did appear the colonisers from the West when the Asian peasants measured them. Sir Arthur Cotton, the founder of modern irrigation programmes wrote [Cotton,1874:23-27]:

> 'There are multitudes of old native works in various parts of India, ...These are noble works, and show both boldness and engineering talent. They have stood for hundreds of years. ..... When I first arrived in India, the contempt with which the

> natives justly spoke of us on account of this neglect of material improvements was very striking; they used to say we were a kind of civilized savages, wonderfully expert about fighting, but so inferior to their great men, that we would not even keep in repair the works they had constructed, much less even imitate them in extending the system'.

Circumstances had led Cotton to discover the proficiencies of some of the indigenous works. But even such persons would relapse easily into complacence. 'All this was perfectly true, till lately', added Cotton, immediately after the cited paragraph, implying that the techniques which the Madras irrigation engineers appropriated under his leadership were all that was to be learnt from indigenous irrigation systems. Others were far more intolerant, nor did the circumstances helped them much to appreciate a very different concept of progress and development. Nor has the situation changed much after the independence; the experts today are often more alien to indigenous society than the colonial administrators, their behaviour, more arrogant. The humility with which Cotton could still appreicate the pride of the colonised peasants is absent among the modern experts.[3] In this article I hope to bring out some of the effects of this 'modern' and 'scientific' outlook first, from a general survey of modern extension programme all over India and then from intensive study of one region, Bihar. In a final section I shall describe some of the lessons I learnt from a case study of a unit of indigenous irrigation work and show, by its comparison to modern systems, what elements of management are at stake.

Chapter I

INDIGENOUS IRRIGATION WORKS IN INDIA

It has been suggested that the Harappan civilization developed on the basis of knowledge about flood cycles and inundation agriculture, just as the Egyptian and Sumerian civilizations [Allchin and Allchin, 1968: 260]. But in Harappan sites no artificial water control system has been identified as yet. It might have been merely the knowledge of annual floods from the Indus which had helped the development of irrigated agriculture. Lately, archaeologists have discovered an irrigation work at Inamgaon, Maharashtra which existed about 3500 years before present. There are some peculiar stone structures called 'gabarbandhs' found in Baluchistan which may be artificial irrigation works. Their ages are still not determined, but those are likely to be very old. Further research may lead to the discovery of many such antique irrigation works. But there can be little doubt that the developments of irrigation systems received a great impetus after the discovery of iron around 3000 years before present. Use of iron had helped extensive reclamation of land for agricultural purpose. Irrigation practices had spread simultaneously flowering into varieties of techniques suitable for diverse natural conditions.

The underground tunnel (infiltration gallery) method of irrigation called quanat or karez is a technique which though widespread in West Asia and Africa, does not extend in the east beyond the borders of Indian subcontinent. Sources, as rare as the springs, which supply the quantas are valuable in the drier west, but not so in the rainfall rich and riverine monsoon Asia. In the monsoon Asia the varieties of surface water appropriation techniques range from storing of run-off water after rainfall

to diversion of flows from big rivers carrying both glacial decomposition and monsoonal precipitation. A further source is groundwater supplies. All these techniques are also used in the west, but scantily, because of the dearth of natural supply.

The three most common types of traditional works found in monsoon Asia are diversion channels, surface-drainage tanks and wells. Diversion channels may be pretty simple - the people of the hill region often throw a few stones to block the course of small drainage streams to divert the water to cultivable fields. In some parts of the Himalayas extensive arrangements of channeling, aqueducts etc. are used to carry such diversion channels, called kuhls or guhls, to far off places. Small streams carrying monsoonal precipitation abounds in the foothills regions all over the country. Similar techniques of diversion for irrigation are used all over these piedmont regions. But here, there are also massive diversion works. The rapid flow of the big rivers cannot be controlled in the steeper slopes on the hills. But in relatively level grounds in the foothils that is also possible. Thus alongside smaller control works on the minor rivers one also finds bigger works. The technique reached the most spectacular development in South India where the major rivers are also controlled in this method. The Grand Anicut, built on Cauvery river during the 2nd century A.D. is one of the amazing engineering excellance of the ancient Indians. The ancient anicut was 300 metres in length, 12-18 metres in width and about 5 metres in depth stretching across the outlet in a zig-zag form.

The readers may face some difficulty with the nomenclature.[4] Therefore, the following hint may be noted. The irrigation systems are often identified by the more difficult operations. The diversion process is much simpler in the uphills and

and therefore, kuhls are familiar for their more complex channelling methods. The small water courses through which well-water is led to fields are also called kuhls in the plains of U.P. But the irrigation systems is more famous for the source, as well-irrigation, not as kuhl irrigation. For the major rivers, the controlling work is difficult and so are the systems more familiar for their anicuts, the weirs. In fact, anicuts are the names reserved for controlling of major rivers though the same technique is used for diverting smaller rivers, even fields channels. Anicuts differ from the 'inundation canals' in that the latter do not have any controlling work in the bed of the rivers. The anicuts consist of weirs but no storage facility in the river beds, a feature common to many modern multipurpose projects. In the foothills regions, where the land is relatively flat but still retains sufficient slope for the water to flow, a weir erected on the bed of a river or a channel does not merely obstruct the flow but also helps its level to rise gradually. The level may be raised sufficiently to divert those to distributaries or to irrigable fields, which are often above the normal water levels in the channels. The technique thus ingeniously uses gravity flow for lifting of water, thus saving much effort. The construction of the weirs in small streams or field channels does not raise much difficulty. But controlling bigger flows certainly requires a lot of proficiency and effort. The weirs are temporary and are removed after the purpose is met, thus allowing the normal flow to resume.

Naturally, the application of this method was restricted to the regions with still a slope (approx.gradient 1: 2000 and above). But such areas are not rare in the country. Apart from the Himalayas the country has hill ranges in the central part and along the east and west coasts. From all these ranges surface level descends gradually towards the valleys of the major rivers or towards the coast often attaining the suitable

gradient for this type of irrigation. Numerous drainage streams traverse thse regions ultimately discharging their supplies to one or the other of the major rivers or to the sea. The anicut method is frequently used to divert water from these streams. However, the intensities differ from region to region. The steeper slopes of the Himalayas or the Western Ghats do not provide as much scope as the gentle slopes of the Eastern Ghats. The arid central Indian region does not have the plentiful water supply and the numerous rivers. Thus the abundance of such diversion techniques are found in the eastern coast of the peninsula, in Tamilnadu and Andhra Pradesh followed by south Gangetic Bihar where Chotanagpur plateau gradually descends to the level of Ganga. In the south the channels are knowns as *kalvai*, in Bihar, as *pynes* and the training works as *bandhs*. In West coast these are known as *bandharas*. Along the Himalayas, the technique is used, with channel construction as more complex operation - from Himachal Pradesh through Nepal to Cacchar hills. Outside India, similar techniques are used all over monsoon Asia, from Afghanistan to Japan, with different emphasis.

But why should one be on the lookout for a natural stream? In such a sloping country the run-off water itself, before it meets a drainage stream - can be appropriated. The topographical conditions permit throwing of an embankment along the slope of the country to retain the run-off water after precipitation. These are the so-called 'tanks' though the name is a misnomer. Essentially, these are three-sided reservoirs with one side (the high side) open for run-off waters to enter. Unlike the regular tanks those are not dug out but consist of elevated embankments over the surface and thus facilitate gravity flow instead of requiring lifting for irrigation. The hydrological principle used is therefore, the same for 'tanks' (*eries*) and the anicuts. But there is an important difference. The 'tanks' are reservoirs which retain the water for future use, unlike the diversion channels. Therefore, the diversion channels

are often used in conjunction with the 'tanks' and unlike storage works in the river beds as in many modern systems, the water is stored in innumerable small reservoirs after diversion. The 'tanks' though have their own catchment basins often are fed in addition, by diversion channels from rivers. Such 'tanks' are now called 'system tanks'.

Tanks proper are found all over the country but are generally used for domestic and ritual purposes. The irrigation 'tanks' with elevated embankments do not have any similarity with the former except for the fact that both are reservoirs.[5] The indigenous names for the two varieties were different. The irrigation 'tanks' are known as 'erie' and 'kanmai' in South India and 'ahar' in Bihar. Kautilya's Arthashastra, written around 350 B.C. refers to ahars (aharodaka setu). Hence this technology must be at least as old as that. Descriptions of these systems are found in earlier litrary sources like Jatakas or Sangam literature. We shall use the name 'erie'[6] instead of the confusing term 'tank'. The eries are generally small, irrigating 20 to 50 hectares each, although the biggest erie of Tamilnadu with more than 20 kilometres embankment and about 100 sq.km bed provides irrigation to more than eighteen thousand hectares of land. Despite the small size, extensive application of the system makes it an important source of irrigation in the country even to this date. Tamilnadu alone has more than 38 thousand eries. Almost every village in the particular region irrigated by this method has one or two eries. Andhra Pradesh and Bihar have comparable extent of erie irrigation followed by the states like Karnataka, Maharashtra, Rajasthan, M.P. and Orissa. The system is found, covering small area, in almost all other states. The total number of such eries all over the country may add up to about two lakhs (0.2 millions). von Oppen and Subba Rao [1980 I : 11] worked out that 'tank' irrigation accounts for about 3.6 million hectares in the country even at present. This may include some regular tanks, but mostly, these are eries. In fact, the area is an underestimate.

In some states, including the extensively ahar-irrigated state of Bihar, the area has been classified as irrigated by 'other sources of irrigation' and is not included in the estimate. By making that correction the total comes to around 4.5 million hectares.

In the steeper slopes in hill regions the drainage streams are rapid and their beds deep. This imposes a limitation on training works. Thus, the diversion channels are rare in these parts and independent 'tanks' are more common. In countries with gentler slopes, i.e. nearer to the major rivers or to the coasts, the diversion channels, often in conjunctions with eries are more frequent. In addition, the gentler the slopes are, the longer are the channels. This is because the channels need to be taken far off before they reach near the surface level only when gravity irrigation is possible. Long diversion channels are therefore, observed only in some parts of the country, the deltas of the major rivers in the east coast of the peninsula. But diversion channels of length ten kilometres or below are found in abundance. In the country with a still gentler slope (e.g. 1:5000) longer channels can be constructed. But several other factors impose alterations in the irrigation technology. Because of the gentle slope the flow of water in these rivers are not rapid. Erection of weirs in the river beds reduces the rate of flow further. Besides, the rising water level may find some depression somewhere in the long stretch of the bed where the levels are rising. This is likely to cause flood instead of diversion to specific channels. Indeed, many of these regions are flood plains of these rivers, whose beds are not very deep because of the silt they carry. During monsoon the heavy natural discharge often overtops the banks and flood control, rather than irrigation becomes the prime necessity.

The massive flood plain of Indus-Ganga-Brahmaputra belongs mostly to this category of regions with gentler slopes. The

traditional irrigation systems here too, had ingenously included the specific features of this region. Control works in the river beds were totally absent. Long channels were still constructed. But those had no controlling works and received their supplies from natural diversion. Depending on the relative heights of the river beds and channel openings the amount of water diverted could be regulated. Some of the channels were so much above the levels of river beds that those received supplies only during the high flows of the rivers.

The primary purpose of these channels did differ from region to region. In the plains near the Himalayas, where the slope is higher those were primarily for irrigation. The channels here have been called 'inundation canals'. But near the confluence, particularly in the Ganga delta which includes the whole of Bengal, the primary purpose was drainage and flood control, though irrigation needs have also been met by these canals. These channels have been known here as 'drainage channels'. In either of the types reservoirs were not necessary. Unlike the piedmont canals, whose contents got expelled rapidly because of the slope of the terrain, the canals of the flood plains retained water themselves and reservoirs like 'system tanks' were unnecessary. The canals could also run much longer. The Jamuna canals ran into hundreds of kilometres. And according to Wilcocks [1930] some of the major rivers of Bengal today were originally artificial drainage channels.

The antiquity of these systems cannot be asserted. But technological considerations suggest these may be quite old. The Western Jamuna canal is reported to have been dug out by Firuz Shah Tughlaq about six hundred years ago [Habib, 1982:49]. It might have been a renovation of a still older work and the technique might have developed much earlier. Beginning with the knowledge of annual inundation the Egyptians had

arrived at complex techniques of artificial irrigation several millenia before present. What happended to the (possibly) similar knowledge of the Harappans is unclear. However, it must be noted that canal irrigation might not have been popular in western India at least in certain parts. The Indus valley probably had extensive system of inundation canals from time immemorial. But much of Ganga valley were altogether unfamiliar with techniques of canal irrigation. Some canals in the Ganga valley were merely royal monuments, probably imitations of West India, but notoriously poor in engineering and with little achievement in irrigation performance /Whitcombe, 1971: 31 fn./ Even in the past there were bad 'modernisation'.

Regarding the irrigation and drainage channels of Bengal doubts are sure to occur not merely about their antiquity but altogether about the existence. Indeed, there is only one such claim, but it was made by a person no less than Sir William Wilcocks, who resuscitated the 4,000 years old irrigation system of Nile and worked on the ancient Sumerian irrigation system. The theory speaks of such grandeiose achievements by the ancients as are simply bewildering. In his lecture in Calcutta University Wilcocks /1930/ explained that the 'natural' drainage system of Ganga-Brahmaputra delta has some geographic features which defy their being natural. Many rivers, including Bhagirathi, could not have attained such courses under natural conditions. Mastering a lot of other evidences Wilcocks went on to suggest that several rivers of Bengal were originally constructed as drainage channels. In his view there is some fact behind the mythological story of Bhagirath leading Ganga to a different course. It is hard to believe, but not so if we remember that the ancients could build weirs on major rivers like Cauvery. Bhagirath had only to breach a bank for diverting the river and mostly, it found its course in the delta until it reached the confluence. It was rather a boldness of imagination than an engineering challenge. It is worth noting that even

in this century conversion of artificial channels to natural drainage course has been observed, so much so that the Bihar Government, while introducing an irrigation Bill in the 'twenties had also included such damages as one of the background reasons.

Well-irrigation is an equally old technique of irrigation and is found in almost all parts though with varying extent. Even in those regions where surface water sources are used widely for irrigation those are supplemented by groundwater uses. Some of the traditional surface water source's dry up after the monsoon. After that the wells form the major source of irrigation during the dry seasons even in parts of rich anicut or erie - served regions. In case of monsoonal failure or for irrigating uplands which cannot be irrigated by surface water, wells are used as supplementary method. But the most intensively well-irrigated areas are the lowlands - often the flood plains or the adjacent regions, where surface water is available in plenty. It is the Ganga valley, particularly in the state of U.P. where extensive well-irrigation exists even now. This may seem paradoxical since ground-water exploitation require lifting and may appear economically inefficient compared to gravity irrigation methods. But there are sound environmental reasons if not economic too.

The Ganga valley has a permeable soil. Wells with only a few metres depth collect water particularly in the areas near the rivers. Many of these were <u>kaccha</u> wells lasting a year or two, but made and remade with little cost. In certain parts even the kaccha wells lasted long. <u>Pakka</u> wells were also built but more so, in areas further away from the river beds. In addition to manual water lifts, animal powers were used extensively. The <u>kaccha</u> wells could irrigate about one or two acres per season and the <u>pakka</u> ones, at the most, about 5 acres.

Almost all the cultivators owned one or more kaccha wells. By an estimate, in 1860-61 there were 70 thousand pakka wells and 280 thousand kaccha wells in the Ganga-Jamuna doab region alone [Whitcombe, 1971: 67-68]. It is likely that similar system of irrigation existed all along the Ganga valley, even up to Bengal. Although canals could have been made, and were indeed made by the British in many of these areas, for a long time those were not popular. The wells were favoured probably because of the simpler management, less wastage of cultivable land for facilitating irrigation and for environmental reasons; the last point came into prominence after the British introduced canal irrigation in this area. Well irrigation had helped this belt to support one of the highest population density in the world.

The specific mention of the low lands of Ganga valley should not minimise the importance of well-irrigation in most other parts of the country. The techniques of surface water irrigation restricts it to small areas, although those are the most prosperous tracts and support very high densities of population. For most other parts, where surface water irrigation facilities are not available, well-irrigation provides for the major source. In uppoer U.P., Rajasthan, Gujarat, Maharashtra in the upland areas beyond the erie countries of Tamilnadu and Andhra Pradesh and probably also in Punjab and Haryana in the past, wells were practically the only source of irrigation available. It is true that the deeper wells required in this part never allowed intensive irrigation, and dry crops predominated. The regions were relatively less populous; arable land was less. For all these reasons wells were not as numerous or as dense as in the Ganga valley. But from the point of local economy they were no less important. It is worth noting that the traditional agricultural techniques developed with thorough considerations about water-availability. Parts of Gujarat for example, have high rainfall and may attract rice

cultivation. But variations are high and in the absence of suitable irrigation methods rice production is sure to fluctuate from year to year. These areas are traditionally known as millet areas. Since first evidence of rice in India has been found from Gujarat (around 2500 B.C.) it is not impossible that the people of these areas were originally rice cultivators. Later, the experience taught them to shift to millets. Reasons such as this one indicates the immense importance of thousands of years of experience.

Apart from these major systems of irrigation there were everywhere varieties of other systems of minor importance. Sometimes the cultivators of eastern regions simply cascade their plots to retain water (gherabandi, see also Guha,1982: 481). Near the rivers or channels they irrigate the adjacent plots by using different types of lifts. Water collected in lakes, ponds,even in road side depressions are used for irrigation. Thus, it is essential that one does not take a simplistic view of indigenous irrigation methods. Besides, we have not discussed the different traditional lifting methods like basket, canoe or wheels; the various ways of using manpower and animal power for this purpose. We have not discussed in details even the techniques of diversion channels and eries. Those have highly ingenious systems of regulation of flows, protection from being damaged by water pressure etc. Though we have discussed drainage along with irrigation we have not discussed either land reclamation and crop practices. These are equally important for proper appreciation of traditional irrigation systems. Discussion of all these aspects in details will require several pages; nor are we capable of doing that. What will suffice for the present article is to understand that the simplicity of most of the systems are deceptive - those were indeed, products of generations of experience and required great expertise in upkeep and maintenance.

Except for the few major anicut systems and big eries, and some of the long inundation canals, which might also have been failed efforts, the extensive traditional irrigation arrangements in the country consisted of crude structures of stone and earth, of bamboo and bricks very often with irregular shape. Sometimes those are so much of the part of nature that their existence is missed by untrained eyes. Often those would collapse. The sizes are not at all impressive. It is just impossible to believe that those may be the results of generations of accumulated knowledge, that in spite of the simple appearence those may often have better performance record when compared to many of the conteporary concrete structures, that their environmental effect are often much better than the modern works. But that is true. The crude eries often formed such interconnected chains that every bit of run-off water flowing through vast landscapes were appropriated for irrigation, every bit of surplus water from one level reached another requiring water for irrigation. The whole of the water flowing through major rivers were appropriated for irrigation and those never reached their confluence. The crude wells maintained the productive nature of an otherwise hostile soil. All these became clear when the modern irrigation engineering made its headway while hobnobbing with the age-old systems.

Chapter II

IRRIGATION 'DEVELOPMENT' SINCE COLONIAL RULE

Although the East India Company had become a territorial power much earlier its interest in irrigation systems in India began only from the beginning of the nineteenth century. In the meantime they were engaged not only in acquiring new territories but also consolidation of their rule over the subjugated parts. In the latter effort, particularly through the consolidation of revenue system, the Company had, for the first time, understood the crucial role of irrigation in agricultural production. The great majority of the irrigation works were often locally managed. But sometimes in its reform measures the Company eliminated certain local authorities who had important functions in the maintenance of irrigation works. Such works then bestowed on the Company. Particularly in the south, both the existence of bigger scale works and the ryotwari and village settlements led sometimes to the devolving of maintenance works on the revenue officials. This must had contributed to the development of awareness among the Company officials about the crucial role of irrigation in Indian agriculture. But it took many more years for an official policy to emerge. Meanwhile, in the subjugated tracts, all throughout the eighteenth century the irrigation works sometimes survived by local efforts and sometimes deteriorated. For example, when the British acquired the Krishna delta in 1766 it was in a fairly prosperous condition. But by the end of the eighteenth century the irrigation system was in a miserable state and the area was largely depopulated [Ramachandran, 1980: 83].

The military wing of the Company, which was responsible for the public works in India, through their civil engineers had made irrigation a subject of civil engineering. By the end of the eighteenth century some Company officials began suggesting

improvement of irrigation works in areas like Cauvery or Godavari delta. But little was done. The inability of the revenue officials in undertaking the maintenance works properly and subsequent wastage of revenue had led to the appointment of a civil engineer as Superintendent of Tank Repair early in the nineteenth century. Besides, the decay of the Cauvery system and iminent danger of whole of Tanjavure being desolate had led to some piecemeal repair. These alone accounted for the irrigation works undertaken by the Company during the first decade of the nineteenth century.

By the second decade of the century the awareness of crucial importance of irrigation had become more general. Even the Directors of the Company in England were able to see the point. Instead of one Superintendent of Tank Repairs a whole maramut (repair) department with several civil engineers was created for Madras Presidency in 1819. Besides, the Cauvery repair works undertaken in the earlier decade had not only failed but imposed recurring expenditure thus inviting innovative solution. The Bengal Presidency Officials too had, for the first time, come across a noticably large system of irrigation in a newly acquired territory under their domain - the Ganga-Jamuna region. The revenue settlements made in this newly acquired region was not perpetual as in Bengal proper. The Company officials were quick to realise the revenue gains realisable from rennovation of the irrigation system in this part.

Cauvery delta had come under the possession of the Company in the year 1799. The maintenance works of the Grand Anicut devolved on them. It would have been done in the same casual manner as in case of other irrigation works in south had it not been for the fact that the danger was much more imminent and massive here. The topographical conditions are such that the natural flow prefers an alternative course and the river Cauvery tends to dry up fast. Within a year or two after

their ascendency, the Company officials noted that the prosperous Cauvery delta would be completely ruined in a couple of years because of drying of the river bed. As the situation worsened rapidly from year to year the Company finally woke up to the contingency and remedial measures were sanctioned in 1804. Essentially it constituted of raising of the embankment level and desilting. The deterioration was checked, but temporarily. Every year the rising levels of the river beds brought new dangers. For nearly a quarter century an incessant struggle was on between the river and the Company engineers. [Ramachandran, 1980: 79-80] Finally, Major Arthur Cotton succeeded in developing a viable plan based on the indigenous technology. The Grand Anicut was renovated in 1838 and immediately proved to be a great success. Later Cotton [1874: 23-26] paid his tribute:

> "....it was from them (the native Indians) we learnt how to secure a foundation in loose sand of unmeasured depth. In fact, what we learnt from them made the difference between financial success and failure, for the Madras river irrigations executed by our engineers have been from the first the greatest financial successes of any engineering works in the world, solely because we learnt from them...."
>
> With this lesson about foundations, we built bridges, weirs, acqueducts, and every kind of hydraulic work ..... we are thus deeply indebted to the native engineers"

On a closer scrutiny however, Cotton's evaluation of his performance does not seem to be thorough. As a civil engineer Cotton had understood the contribution of indigenous technology but not the management. Unknowingly, his renovation plan had also preserved the indigenous method of management which had no less a contribution to the success of his plan. The Madras engineers had learnt for long to concern themselves with the repair works alone. Beginning with the 'tank' repairs

they had not felt any great necessity to involve themselves in distribution and allocation of water. Did these works survive without any management? Certainly not. The local levels of management were expected, though not explicitly, to undertake such tasks. Since the physical structures were not altered the traditional local management groups could still function without much difficulty. The renovation of Grand Anicut added construction and operation of the major regulating works within the tasks undertaken by the Company officials. But the distribution and allocation at still lower levels were not undertaken. Not only did it help in substantial reduction of cost since the old distributaries, water courses and field channels were brought directly into use making new construction only nominal, but also the project raised little management difficulty from the very beginning, as it appears from the available information. While in the contemporary projects in north India the engineers, were engaged in long discussions about suitable management techniques in south Indian canals there was little such discussion. I think the following explanation may be valid. Although the engineers in Madras had not seen the point, their plan must have left the traditional local management practices alive. Such was not the case in north India, where the Bengal engineers had taken up the entire distributive network of the canals, from the headworks along the main lines, branches and distributaries which traversed the country for hundreds of kilometres.

Lack of experience in management as in the south as well as circumstances must have contributed to the different style of works in the north. The last of the old Jamuna canals had collapsed some forty or fifty years back before the British acquired this part. Unlike the southern systems which were still in the operational stages and in all likelihood, had retained the old physical structures and local managements, the Jamuna system was out of use for long and had little

such features retained which could have been revitalised. Distribution and management problems ensued from the beginning and the Company officials in the North had to experiment with several engineering and social control methods. The Jamuna canals were only moderate success compared to the Cauvery system. But it was still a financial success. The viability of such an irrigation system in a traditionally canal irrigated area must have contributed much to the success, Later experience shows the extension of canal irrigation in new tracts inevitably met with failure.

But unlike in the south, over large parts of north-Indian canals, management and environmental problems were rampant. Tracts cultivated earlier fell into disuse; sailinity and waterlogging problems were noted. Often mechanical efficiency in the distribution of water had to be sacrificed because of social and political reasons. The irrigation systems here had played their part in provoking disaffection with the Company's rule and had contributed directly to rebellion of 1857. In course of the 'mutiny' attacks on canal installation were not infrequent [Whitcombe, 1982: 680-692].

Yet the overall success of the pioneering projects and substantial revenue earning opened up the initiatives for development of irrigation. During the next few decades ambitious works were taken up, in the hope of great financial returns. Also new scopes of renovations were found in the lately annexed territories. We need not go into the details which have been described well by Whitcombe [1982: 677-737] in her study. We may note here only a few features of interest for the present study.

The individual projects had varying effects. By around 1875 it was observed that the few works 'of native origin' were the only ones which registered commendable success and helped to show a positive balance in the government's irrigation account [Whitcombe, 1982: 704].

The worst sufferers were the tracts where the topography permitted engineers to extend canal irrigation but for various other reasons the tradition warned against it. But little attention was paid to the tradition;proposals were made for extension of canal irrigation into the well-irrigated tracts in lower U.P. Some of these projects failed to take a start for a long time because of popular resistance. But some others, like the Ganges canal, were completed at a much earlier period. In almost all these tracts the production increased extraordinarily for the first few years of canal irrigation. But very soon the soil quality started deteriorating with hardening of upper soils and formation of saline crust in the subsoil. It was indicated that well-irrigation could avoid such ecological disaster [Whitcombe,1971 : 77], which might have been the reason for non-existence of canals in the past. But now, by the effect of canal irrigation the soil fertility went on decreasing. Hundreds of acres were put out of cultivation. The whole country looked like scortched earth. Contraction of fuel and fodder areas created additional problems. In general, in the canal areas of the north, salinity, canal seepage and water-logging problems reached alarming proportion. This accompanied serious deterioration of public health situation. It may seem surprising today that Amristar was chosen,appropriately enough, as the headquarters of the Government of India's Malaria Investigation Committee. The failures were not confined to the north. Project for extension of canals in Orissa, master-minded by Arthur Cotton, met with equally dismal performances and the work was abandoned after a considerable expenditure. Certain other projects in south India for extending canal irrigation to new areas met with equally bad results. At the same time, even in the north, renovation even extension of inundation canals in Punjab and Sind had paid rich dividends. However, the new proposal of their conversion into perennial system did not attain much promising result. Often the canals replaced an old mode of irrigation at a great financial and

other costs but with marginal improvement in production. Sometimes the cropping pattern changed from dry crops to wet crops or from kharif to rabi. But there was nothing like the tremendous impact the renovation and extensions of Cauvery-Godavari anicuts or the Indus inundation canals.

But the government irrigation programmes touched only a part of the country. What happended to the varieties of other irrigation systems which existed in the rest of the areas? Very little is known about these, and we may provide only fragmentary information supplementing it sometimes with logical understanding. Reports are available for certain well-irrigated tracts of U.P. like the present Sarda canal command area. The people had resisted the project for extension of canal system for quite some decades, which would not have been possible if the traditional wells were not in good functional form. In fact the canal project was finally accepted when the ground-water table began to recede [Whitcombe, 1982: 725]. But even in the later period, when the levels rose again, the people reverted partly to well irrigation. It is likely that this pattern was general. In areas where the government irrigation programmes had not reached as yet, the people continued as far as possible, with their indigenous works. Considering that most of these works were of small size and within the management capabilities of the people the continuation would not seem impossible. Sometimes some of these were affected by changes in physiography, as the sinking of water table in Sarda command area. But this need not be a reason causing extensive decay. A far more important factor may be the indirect effects of civil reforms undertaken by the colonial government. Unlike the wells, the eries and such other works required social management, which might have ranged from communal to authoritarian management by local overlords. The reformed civil systems had continuously restricted the scopes of such local social systems. It is likely that by the

cumulative effect of these impacts even the 'unnoticed' irrigation systems were deteriorating continuously over the whole period and had substantial contribution to the severity of famines in the country during this period. In a latter section, with a case study of Bihar, we shall try to trace the developments of such 'uncared for' smaller works.

About the other large work, the drainage and irrigation works of Bengal, Wilcocks [1930] provides a detailed picture. The massive and vastly complex works were never understood by the colonial rulers. The zamindari embankments, which ran for kilometres all along the flood prone rivers, were understood only as flood protection measures. Wilcocks opined that those were also for irrigation; whenever the peasants were in need they only breached the embankment for diverting water which Wilcocks termed 'overflow irrigation'. The British never understood this system and took stringent steps to protect the embankments. Every year as many as 40-50 breaches appeared in each heavily embanked river of inconsiderable length. The peasants and zamindars made these breaches secretly for effecting irrigation. Finally in 1855 by taking over the embankment the government was able to stop such 'damages'. Thereafter, the embankments were strengthened, their numbers increased. As a result overflow irrigation practices stopped. In addition the drainage of monsoonal water into the rivers was greatly restricted. Lastly, embankments for roads and railways were added. Wilcocks called the series of embankments along each river as 'satanic chains'. Large areas became waterlogged; public health deteriorated seriously. Once prosperous tracts like Burdwan became near desolate. Bengal never fully recovered from the deprication.

Although in south India the maintenance of some of the minor works of irrigation devolved on the colonial government and they had to create a whole department for tank repair, it never developed into anything more than mere financing and

labour employing agency. Whatever technological challenge was undertaken was with the large scale irrigation works which could meet the aspirations of the civil engineers. Throughout the nineteenth century there were sometimes mad rush for such large scale irrigation projects, sometimes the pace was slackened because of a 'mutiny' or for poor performance of most of these works. By the close of the century the government was confronted with yet another uncomfortable truth as to the value of its irrigation works. The protective and preventive power of irrigation was not merely most successfully exercised in the erstwhile most productive areas where agriculture prospered even without canal irrigation, but indeed, these seem to be confined to those areas because topography of other areas did not favour canal construction. Famine Commission in 1879 had already pointed out this regional limitation. They had indicated that no irrigation works had yet paid their way in united Bengal (i.e., Bengal, Bihar, Orissa, Assam), Deccan, Gujarant, Central Provinces and up-country Madras (Present up-country South India) The Famine Commission had also indicated that the localities in which large-scale irrigation could be undertaken with significant advantage were becoming exhausted [Whitcombe, 1982: 716-717] The neglected areas, with physiographic condition unsuitable for large-scale irrigation, were not without agricultural problems. Indeed, the great famines of the nineteenth century had hit hard these areas in particular. The Irrigation Commission, set up in 1900, drew attention to the minor irrigation works, which alone are suitable for such upland terrains. The Commission also brought into focus the management problem of the minor irrigation works like the 'tanks'.

We need not enter into the details of the expansion in this century. Suffice it to note that attractiveness of the major irrigation projects to the engineers still remained as strong as earlier, though minor irrigation too made some headway. Particularly since independence the obsession with irrigation in general and with major irrigation schemes in paritcular, has increased tremendously. Extensions have been

done defying all environmental norms, wherever there is technological possibility, no matter what is the requirement. The increased interest in the production of hydel power, needed for industrialisation, has seen the inclusion of multipurpose river valley projects, often with adverse effects on agriculture and irrigation. A naive notion of development, an urge for engineering achievement has probably worsened the agricultural conditions in the net effect. The extension of canal systems in areas where the engineering possibilities existed but were not desirable due to environmental conditions was limited during the colonial rule. The renovation of traditional canals were practically exhausted. In the post-independence period therefore, further extension of canal irrigation has reached mainly those areas where it is undesirable. The result has been the repeatation of the same adverse effects noted in the nineteenth century, but at a greatly alarming rate. The country has invested after independence till 1979-80 a sum of rupees 7510 crores in major and medium irrigation projects creating an irrigation potential of 16.9 mill.hectares, much of which has remained unutilised. The Public Accounts Committee of Parliament noted that out of a total of 205 major projects taken up since independence only 29 were completed till the end of 1979-80. In regard to medium irrigation projects, out of 916 only 469 could be completed during this time. All such projects were practically loss-making concerns. Cumulative losses on irrigation projects were about rupees 2053 crores between 1975-76 and 1981-82. But that is only a part. Water-logging and salinity, the problems noticed in the nineteenth century during extension of certain northern Indian canals in the unsuitable areas, have assumed staggering proportion. By an estimate made by B.B.Vohra, Chairperson of National Committee on Environment Planning, nearly seven million hectares of land have already gone out of production because of severe salinity and an additional six million hectares of land are lying seriously affected by waterlogging. This is nearly a

half of the total area served by the major and medium irrigation projects in the country. At least six million hectares of this was productive till the other day and have been lost to waterlogging and salinity /cited in Agarwal et.al. ed.,1982:6-7/. An alternative estimate made by Bowonder and Ravi of Administrative Staff College, Hyderabad shows a much higher figure. They estimated that roughly ten million hectares of cultivated land are affected by waterlogging and another 25 million hectares by salinity problems, and those are no longer fit for cultivation. These estimates reveal that 56 per cent of the land irrigated by all systems, ten million hectares more than the total land under canal irrigation, is in imminent danger of going out of cultivation /cited in Joshi and Agnihotri, 1984: 529/. In some of the irrigation projects the productivity of crops have stagnated after an initial increase, in some others it is actually decreasing. Aquatic weeds are posing a serious threat to most of the canal irrigation projects. In the states of W.Bengal, Bihar, Orissa and Assam these weeds have infested roughly 40 per cent of the total cultivable area /Joshi and Agnihotri,1984/. No precise estimate is obtained about other environmental disaster brought by large-scale irrigation projects - like soil erosion, increasing incidence of flood or from destruction of forests from inundation and for resettlement of displaced persons.

The overall balance sheet is so very unimpressive that one simply feels like labelling modern large scale irrigation projects as complete failures. Therefore, it is necessary to pinpoint that several projects like the Grand Anicut or Sind canal renovation projects are also included among the modern works, no matter that those were undertaken only at the very early stages. If not as brilliant as the above two, many other projects have registered considerable success in one or the other aspect of water control. In fact, modern engineering has much to contribute if only it develops along indigenous knowledge as against by rejection of the same.

Cotton did not only appropriate the indigenous technology but had also improved it with modern engineering knowledge. Only with such improvements it was possible to erect embankments on larger rivers like Godavari. One may site many such examples to establish the utility of modern techniques. The failures arise from the fact that modern engineering has also rejected the traditional and popular knowledge - a feature that is most severe in countries with a colonial heritage. The environmental dangers of canal irrigation in many parts of the country were well-known. But the modern engineers never felt any need to heed to this knowledge. When the people resisted the undesirable engineering efforts those were simply taken as their foolhardiness. They have pushed in irrigation systems in such areas where drainage is a more severe problem. In some other areas they have forced banishment upon viable indigenous methods of small scale irrigation. Many of these could have been avoided and can still be avoided if only they are ready to pay attention to the indigenous knowledge. Japan and more recently China have attained considerable success by basing their modernisation programmes on traditional methods as against on negation of them.

Although this section was purported to deal with irrigation 'development' in the whole of the country we have not dealt much with minor irrigation methods. Currently minor irrigation accounts for nearly a half of the irrigated area in the country. But its features are so very diverse that a general picture for the whole of the country is difficult to draw. Therefore, we shall restrict our attention to a limited area. In the next section, through a case study of Bihar the problems of minor irrigation have been brought out in some details. How much of it can be generalised will be open to question. Neverthless, the treatment will provide some idea about the specific nature of problems faced in the minor irrigation front. However, we may include here a couple of general remarks about minor irrigation systems in the country.

Development of minor irrigation works on a systematic basis began particularly since the recommendation of the first Irrigation Commission in 1901-3. Most of the eries and wells come under this head and tubewells, manual or energised, have been added. The traditional systems, eries and wells, are facing several difficulties from extension of major irrigation works and management problems. Some of these have already been indicated, some more will be discussed in the next section. The environmental problems posed by the extension of minor irrigation works are much less. This is somewhat explained by the fact that the peasants, not the engineers, act as final promoters. Nothing like forced extension of canals can occur under this head. However, excessive use of groundwater has already started posing environmental problems. In many areas groundwater level has been depressed and the areas may face crisis of supply in near future.

From the purpose of the present study another aspect of minor irrigation policy deserves attention. Minor irrigation works like eries often formed 'system tanks' or 'chain tanks' releasing surplus water from one level to another and thus, in reality, forming a huge system covering a whole area. The policy to treat these works individually as minor systems have restricted the possible contribution of modern development. Indeed, the whole areas should have been treated as major systems. Traditionally, such network of indigenous systems have been able to utilise every drop of run-off water available in the region. But modern irrigation engineering does not show any eagerness to take up such radical challenge; the engineers are quite content with repeating the same techniques at an increasingly massive scale. What is considered as a 'bold imagination' is something like the garland canal project which purports to repeat the same hackneyed techniques of canal construction but at a cost of rupees 5000 crores at the minimum.

Chapter III

A CASE STUDY: BIHAR

The state of Bihar, extending over an area of 173.9 thousand sq.kms., has got three distinct geographic regions. The hilly region in the south (Chotanagpur) and south-east (Santhal Parganas) covers slightly less than a half of the total area. The rest is the Gangetic basin. The north of Ganga, popularly known as 'North Bihar' is a continuous plain made of new alluvial soil. The southern basin known as 'South Bihar' - not to be confused with Chotanagpur - gradually descends from the Chotanagpur plateau to the level of river Ganga. The southern boundary of 'South Bihar' corresponds more or less too 150 metres contour line and the whole plain has a gradient around 1:1000. Mostly it consists of old alluvial soil. The western part of this plain is the driest area in the state. Average annual rainfall in Bihar varies from less than 1000 mm. around Patna and Gaya to above 1400 mm. in the east and extreme south. The variability of rainfall too is high in the districts around Patna.

Saran and Muzaffarpur districts[7] of North Bihar are adjacent to Patna and are included in the low rainfall region. But being on the north bank of Ganga those are protected to some extent by the water retaining property of the new alluvial soil. It is the southern plain of Ganga, in the districts of Patna,Gaya,Shahabad and parts of Monghyr,Bhagalpur and Palamau, where the problem is most acute. Besides low rainfall and a soil with little capillary property the area has a marked slope from south to north causing quick flow of water. And while being drained out this way the monsoonal discharges are liable to cause flood in the adjacent areas. Yet,in spite of all these adverse conditions this area has been one of the most populous tracts for more than 2500 years.

As has already been discussed, the physiography of South Bihar is suited for the so-called 'tank' irrigation. The local name for 'tanks' is ahar. Since the term finds mention in Kautilya's Arthasashtra there can be little doubt about the antiquity of the system. Even at present nearly 0.9 million hectares[8] are irrigated by ahars and pynes (diversion canals) the equivalent of system tanks. The system is so well developed that even now, after much deterioration the flow of many of the smaller rivers never reach Ganga. However, in the irrigation statistics collected by the government ahars and pynes are included not under the head 'tanks' but under miscellaneous 'other sources' of irrigation. And that makes almost 30 per cent of irrigated area in Bihar served by uncared for 'other sources of irrigation'. In the all India total too the state has lion's share of 'other sources of irrigation'.

In the southern part of the South Bihar plain, nearer to Chotanagpur plateau, where the gradient is sharper and the watersheds between rivers are well-marked there is not much scope of making pynes. The rivers are rapid and are subject to sudden and severe flows. Silting is heavy and the diversion channels cannot be led much away from the rivers. In this part therefore, most of the irrigation is done by storing rainwater. Pynes are rare and ahars alone, called 'hirs' or 'bandh', are found. Further south, inside Chotanagpur plateau too, the same system of run-off water storage is observed. Although irrigation needs in Chotanagpur and Santhal Parganas are not as acute as in South Bihar, the area still requires irrigation for successful cultivation.

Unfortunately very little can be said about the antiquity of the irrigation methods, or for that matter, even of agriculture in general for this part of the state. This area is known as a tribal region and historians in the country have

made little effort to study the history of these people. Just because they have been termed 'tribes' by the government it becomes acceptable that they do not practice agriculture or have learnt it in the more recent period. There are many communities in these parts who are not scheduled tribes. But without any inquiry such communities are regarded as migrants. Thus agriculture practised by them is also considered as recently introduced.

If one may recover from the deadweight of this administrative myth supported by high academics one may look at the history with some amount of objectivity. It is more likely that these 'tribal areas', if not Chotanagpur, contained the precursors of irrigated and agricultural civilizations of the later period. In the monsoon regions in the remote past such uplands have been the suitable places for human settlement. The marshy and swampy lowlands infected with disease carrying insects, the densely forested flood prone countries had very little to attract the ill-equipped ancient cultivators. In contrast, the uplands in monsoon region could provide much for early cereal cultivation. There it is easier to prepare land for this purpose - one has to remember the slash and burn cultivation methods. With the abundance of springs, gentle streams and natural ponds irrigation is much easier. It is more likely therefore, that the development of edible varieties of seeds, the elements of cultivation and irrigation techniques had first developed and spread along the upland areas. It is only after the discovery of iron that they were able to clear, on a grand scale, the dense forests in the valleys. The developed irrigation and agricultural techniques which appear suddenly in the valleys might have been developed from the rudimentary forms in more hospitable areas. Archaeological evidences also support that rice was developed first as an upland variety.

The undulated condition of the terrain in Chotanagpur and Santhal Parganas restricts area available for cultivation. In the interior areas the cultivable fields are often isolated small patches of level ground. If near the field there is a spring or a small natural drainage channel, which are found widely - those are diverted by blocking the flows. This require little effort. A much larger scale indigenous irrigation method is that of <u>hirs</u> or <u>bandhs</u> which resemble <u>ahars</u>. Some of the bandhs are very big and contain water perennially. The method of distribution of water from the <u>hirs</u> are somewhat different from that of <u>ahars</u>. The fields stretch away from the adjoining lands, each on a lower level than another and widenning as they recede from the bandh. Thus those resemble the famous terrace cultivation of the Himalayas or of Nilgiris (also of East and Southeast Asia). However, Chotanagpur and Santhal Parganas are parts of age-old Peninsular Foreland. Unlike the young Himalayan range it is a much eroded plateau. The terraces here are therefore, much distantly placed with wider levelled grounds in between when we compare those with the terraces of Angami Nagas. It may be noted that faint resemblance to terraces are observed when one looks towards the horizon while in the 'tank' country of South Bihar or Andhra Pradesh.

Though many other communities practice <u>hir</u> irrigation the Santhals are most famous for it. The Santhals are a well-known 'tribe' and equally well-known cultivators. Even as late as in 1938 the District Gazetteer of Santhal Parganas described [Bihar, 1938: 208]:

> "The Santhal is a born reclaimer. He has an eye which is expert to take advantage of the inequalities that exist in the surface of the country. He knows where to throw his cross-bundhs and where to make his terraces."

The extent of hir irrigation can be indicated only as a rough estimate. At present those rarely survive for reasons which will be described later. Till 1931 as much as 10-17 per cent of gross cropped area in Palamau, Singhbhum and Santhal Parganas districts were irrigated by some source or other (Table-2). This includes many other sources of irrigation like diversion of natural springs and drainage channels and even some wells apart from hirs and bandhs. On the other hand the topography of Chotanagpur varies widely and many cropped lands like those located in level grounds adjacent to bigger rivers or in natural depressions could depend solely on rainfall, whose amount and regularity is far better than that of South Bihar plains. It may not be unreasonable to assume therefore that extension of advanced agriculture in the more difficult parts of the terrain was made possible only with the help of some type of irrigation. The District Gazetteer of Santhal Parganas noted [Bihar, 1938: 203] that there was no village in the district without one or two bandhs at least.

Because of their deep beds the major rivers of Chotanagpur and Santhal Parganas cannot be used for canal irrigation. For the same reason the settlements do not suffer from floods. Once they cross the plateau the same rivers create havocing flood and are also used for irrigation. Because of low water-table and abundance of small surface water sources wells too are rare in Chotanagpur and Santhal Parganas. Springs, streams and depressions are limited in number and can help irrigation of only small patches of land. Thus hirs and bandhs account for the major part of irrigation. Lest our discussion convey a wrong impression let us note that in South Bihar plains too other modes of indigenous irrigation have been in use whenever there is a scope. Wells are dug even though the water-table is low. The whole plain is sprinkled with numerous outliers of Chotanagpur plateau and the rare springs, streams and depressions are used for irrigation just as in Chotanagpur.

A more common method is direct irrigation of fields adjacent to rivers using canoe. But together those account for a small part and were no match for ahars and pynes in preponderance.

In the continuous plain of North Bihar, flood and water-logging was a more serious problem than requirements of irrigation. Even the drier west districts near Patna have a soil with good moisture retaining capacity. Irrigation systems were the typical of Ganga flood plain. Irrigation needs were met easily by wells as in U.P./ In the dry district of Saran as well as in parts near Ganga in all the northern districts, wells strike water at a couple of metress depth. Numerous kaccha wells, lasting for a year or two, used to be dug in here either regularly or with the first sign of draught setting in. Further north, there were irrigation arrangements only in some small areas. For example Beniapatti thana in the district of Darbhanga was irrigated by a complete system of pynes till the beginning of this century/Bihar,1907:52/. But far more likely, it seems, was complete absence of irrigation arrangements. The cultivators were reported /Bihar,1907:56/ to have a belief that irrigation forms a crust of salt in the soil and once applied need to be repeated for all subsequent years to revive the capillary action. As the experience of U.P. canals show, the popular belief was not without grounds.

All parts of Bihar may be considered flood-prone, but the nature of flood differ from region to region. Following heavy downpour in their catchment areas even the tiny rivulets of Chotanagpur as well as South Bihar plains swell up into rushing torrents which often overtop the banks. But because of the gradient of the country such floods clear out quickly-- in Chotanagpur within a few hours, in the South Bihar plains, in affew days. In contrast, in North Bihar, flood water does not clear up easily because of the flatness of the plain as

well as the water retaining capacity of the new alluvial soil. The big Himalayan rivers which traverse the country do not only carry great volumes of flood discharge but also silt which constantly raise the beds of these rivers. The rivers, thus change their course from time to time, a problem, which exists also in South Bihar, but at a much smaller scale because of the small sizes of these rivers. In North Bihar, the whole of the eastern part, the Kosi basin, remained sparsely populated until the flood-control measures were undertaken after the independence. To the west of Kosi the problem is not so acute. But drainage is still a severe problem.

It is difficult to write about the traditional drainage arrangements for little details have ever been noted about this aspect. Understandably these may be as simple as field arrangements facilitating pplot-to-plot draining. Observers have rarely shown such intense observational powers so as to note such details. About the bigger works, it is claimed that there are some traces left of a drainage work in Saran district constructed probably by Sher Shah or at a still earlier period [Ramachandra, 1938]. From the description those appear to be similar to the drainage system of Bengal discussed by Wilcoks [1930]. The essential feature of the system was to provide several additional channels to the tributaries of Ganga flowing through North Bihar so that the pressure at the natural confluence did not become very high. These were known as drainage cuts though 'overflow irrigation' from the channels could be availed during the periods of necessity. In the additional channel method, much of the flow is diverted away and the precipitation too. occurs partly, in the interiors, often enriching the fertility of the overflow irrigated soil.

Because of the deep beds of the rivers, flash-floods of Chotanagpur and Santhal Parganas do not spread over large areas. Beyond this country, while in the plains, those rivers create very serious floods. The flood proneness of South Bihar was

greatly reduced by the extensive networks of ahars, fed by pynes originating in rivers. Till the end of nineteenth century Gaya district was immune not only to famine but also to flood.[9] In South Bihar plains mild floods have often been regarded as desirable. Even at present villagers sometimes com-complain that flood-control measures have done disservice by robbing the soil of fertility [Pandey, 1979:40].

Thus, there was hardly any major indigeneous irrigation works in Bihar to draw attention of the modern engineers. Regarding the multitude of smaller works the point that comes foremost is almost total ignorance among the officials about their very existence. This fact is largely explained by the type of revenue settlement undertaken in this part. In the zamindari areas the irrigation works like eries were settled with zamindars on the assumption that they construct and maintain these works. In ryotwari areas in contrast, the ownership of such social irrigation works could not but vest on the government; the revenue officials automatically became concerned with the maintenance of irrigation works. The difference was reflected also in financial matter. While in zamindari areas the government merely instructed the zamindars to spend a certain percentage of their revenue collection for the upkeep of irrigation works, in the ryotwari areas, for the same purpose, the government itself had to spend large sums of money from its revenue, Soon it was found that the revenue officials were lacking in the knowledge necessary for upkeep of irrigation works and government revenue was being wasted. Thus, by the beginning of the nineteenth century an engineer was employed under the title of Superintendent of Tank Repairs. The personnel strength went on increasing and by 1819 a whole department headed by civil engineers was functioning in ryotwari areas. By around the 'thirties the department could produce such knowledgeable experts like Major (later Sir) Arthur Cotton, who were fairly well acquainted with the indigenous systems of irrigation and could revive with remarkable success,

several old works inclyding the Grand Anicut. During the same time, in zamindari areas most of the indigenous systems faded into oblivion. Once-in-a-while a traveller like Buchanan [1810-1813] would note their existence with amazement or an administrator like Navin Chandra Sen would note the strange phenomenon while writting his memoir. As late as in 1893 another administrator, George Grierson also expressed his amazement while writing his notes on Gaya district. But that was of little importance (or usefulness) for practitioners. For some reasons, as we shall discuss later, there was an increased interest about some of these irrigation works during the first few decades of this century. But soon the matters have settled and the works have passed into oblivion. Thus, the Irrigation Team appointed by the Planning Commission for reviewing the minor irrigation works in the country declared [India,1966: 8], "In the alluvial regions of Punjab and Uttar Pradesh as also in Bihar there are not many irrigation tanks".[10] We are told that the Team of experts reached this conclusion after a 'statewise field survey'. And then, with such great observation power and expertise, they made recommendations for the development of minor irrigation systems in the country.

Should not we expect rapid deterioration of the indigenous works under such gross negligence? Well, that calls for quite an interesting debate. The works suffered no doubt, but not to very great extent. Indeed, that was the reason why the colonial government could afford to ignore them. If their decay would have set a state of alarm that would have forced reckoning as it was in Cauvery delta or even here during the first few decades of this century. In nineteenth century however, each one of the observers, be it Buchanan or Navin Sen or Grierson, came out with highly impressed opinions about the functioning of these systems. Later, following the Famine and Irrigation Commissions, when each different regions of the country were reviewed it was found that Gaya district, the most well-developed area from indigenous irrigation works, was immune to famine (and also flood) throughout the nineteenth century, a fact which was ascribed to this system of irrigation.

The colonial government held the intermediaries as responsible for everything good or bad. The appreciable state of affairs in indigenous irrigation was explained away quite easily as that the zamindars of South Bihar plains were good enough to look after the upkeep of such works. The fact that many of these works survive even after zamindari abolition (and indifference of the government) belies such contention. The total area irrigated by traditional surface water exploitation techniques - ahars, pynes, hirs and bandhs accounting for overwhelming proportion - has come down from 1.32 million hectares in the 'thirties to 0.87 million hectares in 1975-76.[11] But still, even after zamindari abolition so much survives. In order to understand the management process I studied intensively one of the surviving indigenous works. I shall discuss some of the observations in the next section. The zamindars' responsibility, it was observed, was confined mainly to intervillage distribution of water from a common source. Within the villages the village communities - if I may use the inappropriate description for the sake of brevity - maintained and operated the works. Throughout the nineteenth century most of these communities could survive and by their effort survived the indigenous works. The major deterioration that occurred during this period was in the supply channels (pynes) since many of the zamindari estates were partitioned and in consequence intervillage distribution, the sphere of activity requiring the intervention by the zamindars, suffered. By the close of the last century this created an awareness in the administration which brought government intervention in the first decades of this century.

Many of my friends have snubbed me for inventing tradition, many other have been happy for my efforts to reestablish 'our glorious tradition'. Hence I should explain, before I proceed further, what is that mysterious 'community'. No, I did not observe the harmonious village. All the villages I observed in South Bihar were full of conflicts on social issues, divided on economic or political questions. But still, in a

number of villages hundreds of people volunteer even now for maintenance of indigenous works. I may remind that even Oscar Lewis, who had excelled in focussing the feuding nature of the Indian villages had observed that the irrigation works were included among the small number of tasks when the hostile factions of the village united for some common action [Marriot, 1962:192]. And this 'community' which takes up such action is of interest to us. Communal works of irrigation, called <u>kudimarammath</u> in South India and <u>goam</u> in South Bihar, are still widely practised. In South India there is detailed legislation for securing such work. In Bihar even that is absent. There is little legal provision to punish the absentees. But still <u>goam</u> occurs, every year, in hundreds of villages in South Bihar. To verify this one needs making merely an inquiry from the villagers in some of the South Bihar villages. It is not even a rareity. In fact one may learn even about massive intervillage <u>goams</u> which occur at times. In the drought year of 1982 thousands of villagers from several villages had assembled in a <u>goam</u> to divert river Punpun, at a site only a few kilometres away from Patna, the state capital.

There is an explanation why such a system persists. In absence of an alternative, either in the source of irrigation or altogether to agriculture, the peasants need to maintain the traditional source. And they do it even by making some adjustments that is required for upkeep of these irrigation works. Only when there is an alternative the volunteers and enthusiasts fall out from <u>goam</u> and in consequence, the indigenous irrigation works too become derelict in a few years time. The colonial administrators had seen <u>goam</u> as forced labour (<u>begar</u>) for the zamindars. But it is interesting to note that the peasant organisation in the 'thirties, the <u>kisan sabha</u> had never taken such a view. Though they fought begari tooth and nail they never opposed <u>goam</u>.

The zamindars of South Bihar were no less notorious than their counterparts in other areas. But they had little to gain by disturbing the goam arrangements or irrigation works, at least to begin with. Thus the deterioration remained restricted to that of the supply lines (*pynes*) after partitioning of estates.

But then, following the enactment of the first Tenancy Act the relations between zamindars and tenants deteriorated sharply since the beginning of this century. Among other methods used by the zamindars to bring the tenants to their terms during the Survey and Settlement operations was choking of irrigation facilities. The rights of zamindars on these works recognised in the Permanent Settlement had remained dormant for a whole century. But now it proved to be a powerful weapon for the zamindars. The tenants reacted vehemently. The South Bihar districts became the storm centres of *Kisan* movement in Bihar probably because the land disputes here were multiplied with irrigation disputes. The *goam* organisation methods like drum-beating for assembly were widely applied during the movement. The government for the first time became concerned with these works and for only this period there are some reports available. In some places, as an ameliorative measure, the government took steps to reduce the rents on the plea that the zamindars, responsbile for the upkeep of irrigation works, have failed to do so. Yet, it appears from the available statistics that ultimate damage was marginal. Probably, the extreme importance of irrigation works in this area had helped good senses to prevail at the earliest.

And then came independence - the government stepped into the shoes of the zamindars admitting responsibilities to construct and maintain these irrigation works. Since then the Public Works and the Minor Irrigations departments are taken to be the agencies which carry out the maintenance works. Not that they have not done anything. They have laid some hume pipes

by replacing the old hollowed palm tree trunk outlets. Sometimes their men appear to repair the embankments of one or the other of the pynes.[12] But anyone familiar with physical structure of these irrigation works will understand that with such operations alone and under such irregularities the works cannot remain intact for years. The Bihar government, unlike the Tamilnadu government, does not have any policy or even the details of the surviving indigenous works. Those are included in miscellaneous 'other sources' of irrigation about which one puts little thought. But the works survive, or more correctly, the peasants require that those survive. The obstruction put by the zamindars have been removed. The communities have materialised again wherever there is acute need. And thus survives indigenous irrigation works in South Bihar plains irrigating even at present no less than 0.9 mill.hectares.

In no previous period the ahar-pyne system of irrigation has suffered so badly as it has in the post-independence period. The extent has shrunk by about a half during the last three decades. For the most part it has been made possible by the availability of alternatives, in the name of modernisation. There would have been little ground to object if the change would be beneficial. But the facts raise doubts. Canals and tubewells have been introduced in tracts which were well-served by ahars and pynes. The gross area irrigated has increased only marginally scarce resources have been spent merely for replacing one type of irrigation with another. In addition, it has created problems in land acquisition, altered land use pattern and introduced bureaucratic management. It would have been far more economic if the projects would have incorporated the existing ahar-pyne systems in each command area and were made only as supply lines to the existing alignments. This was indeed, the clue to the amazing success achieved by Arthur Cotton in re-novation of Cauvery system. Besides economising on the construction of distributaries and field channels the Cauvery

system had also benefitted by utilising the prepared land and local management facilities existing along the ancient distributaries. In contrast, one has to look into the affairs of any canal system in South Bihar constructed in the post-independence period. A study by Pandey [1979] about Kiul-Badua-Chandan project in Monghyr and Bhagalpur districts report that out of the six villages (three irrigated and three unirrigated) selected by the Command Area Development Agency for their study as many as three have captive ahars in the villages. Two of these ahars do not receive any supply from the canal system. In village Rampur Bisai the flow of water into the large ahar has been curtailed because of the construction of a dam under the canal project. The ahar, pynes and field channels, exist even now, but are in bad state of use because of watershortage [Pandey, 1979:40]. Village Halsi is considered by C.A.D. agency as an irrigated village. It was irrigated no doubt, but not from canal. The alignment of the canal was such that most part of the village land received no water from it. The villagers irrigated their fields from an ahar. The project details had never made any such provision for supply through ahar. But now, the canal authorities insist upon paying of water charges on the plea that the ahar receives its water from the canals [Pandey, 1979: 37-38]. Out of the three villages in the study where no major indigenous work (ahar) has been reported[13] only one has benefitted substantially from the canal system. Another village, supposed by the C.A.D. agency as irrigated is only scantily so [Pandey, 1979:16].

The prospect of incorporation of existing ahar-pynes in the new systems is not unknown to the government officials in general. For example, in his note on Pitambarpur Scheme (a part of Uderasthan Project) written sometimes in 1978, the Chief Engineer called attention to the importance of ahars and recommended linking of the scheme with such ahars. This may not be an exception either. But little progress is made in the suggested directions. There are difficulties on the part of the planners and engineers, to break away from the conventions. There is little guideline available (particularly

because the ahars have never been seen as parallels to South Indian 'tanks') in Bihar for such works. Besides, there will be such difficulties as in collection of water charges if the indigenous systems are included in the canal projects. No less important is the reason that economy on project costs in Bihar will mean loss of earnings to several parties who are engaged during construction.

Even where the canals have not come to undermine the indigenous irrigation systems the state of affairs is not necessarily good. If not canal, the pumpsets are available today as alternative sources of irrigation. Those who can afford to purchase such appliances are not dependent on *ahar-pynes* and abstain from community works. The participation in *goam* reduces from year to year and the indigeneous works ultimately come to collapse. In the life of an irrigation community there comes years of crisis. Because of a draught for example, or due to an intense feud in one year, the indigenous irrigation works fail to provide sufficient help in one or the other years. During all such years the peasants are eager to avail other sources of irrigation and all those who can afford acquire pumpsets. The availability of electricity and diesel have made lift irrigation a viable alternative - manual operations from wells could never compete with gravity irrigations like from *ahars*. The acute necessity of irrigation motivates villagers to recoup in a next period. But those who have already acquired pumpsets become reluctant and ultimately drop out from community labour. As the process is repeated the accumulated effect reduces the participation rates for community works making the remaining participants worried about the future of the indigenous works. They too become eager to secure such alternatives. Finally the community works cease to exist. But don't let me mislead you. That is what is 'development' - the long awaited advancement of capitalism in agriculture. What I have depicted as the period of decay of traditional works is indeed the period when the people have ultimately adopted modernisation ; the number of pumpsets, and with it cash crops, fertilisers

and pesticides have increased. No doubt the poorer ones, who cannot afford to purchase pumpsets ultimately suffer from the collapse of the indigenous works. But differentiation is also a part of capitalism. There is an environmental effect, in addition. Stored water in *ahars* had also contributed to re-charging of groundwater in the locality. The watertable sinks down in all such villages where the indigenous works have ceased to function. As a result lift irrigation becomes difficult. Though not yet a serious problem I have heard some such cases from the villagers of South Bihar.

Little is known about the condit[illegible] the indigenous works in Chotanagpur and Santhal Pargans du[illegible]g the period under review. We have only tidbits of information [also see Wadhwa,1978: 108-111] like that sharp deterioration occurred immediately after the nineteenthirties (see also Table - 2). We have some knowledge about the reasons of such decay. Under the special Regulations certain parts of the region were settled as *pradhani* villages. In such villages the zamindars were legally prevented to deal directly with the tenants, Santhals or others - and were required to proceed only through the headmen or *pradhans*. In course of time the *pradhans* became oppressive and exploitative to their charges which favoured the demand for abolition of this systems. But just as in case of zamindars of South Bihar, even in their condemnable roles the pradhans were still well-disposed to local irrigation works. As long as pradhans were the ultimate authority to sanction transfer of lands the village communities never felt any difficulty in acquisition of land or other necessary adjustments required for community irrigation works. The abolition of the system, therefore, affected the community works severely. In a couple of years the irrigated area shrank drastically.

The extension of modern irrigation facilities in Bihar date back to 1869 when the construction works on Sone canal had begun. From all accounts this is the only meaningful modern irrigation work in the state. Shahabad district, with very few smaller rivers, probably had very little indigenous works.

Sone river could have helped; but techniques for harnessing of such big rivers were still unknown in Bihar. The anicut built on Sone by modern engineers therefore fulfilled a long awaited need. The colonial government had also encouraged the zamindars to extend irrigation facilities. But response was rare. In North Bihar two tiny canals were constructed another one in Drabhanga was abandoned after some time. Nor had the zamindars shown sufficient enthusiasm to construct embankments for flood protection.

Until independence these were the only modern works of irrigation though the state had extensive indigenous irrigation works. Some further extension was done during Grow More Food Campaign when tubewells made their first inroad, mainly in the lower levels adjacent to the rivers. In late 'thirties, after severe flood had caused extensive damage over large areas of North Bihar, the Congress Ministry in the Province had shown much concern for flood control measures. After independence the Kosi project was undertaken which was originally conceived as a flood-protection measure. But later, largely because of the influence of World Bank, irrigation was also added to its purpose in spite of objections from many different quarters. After thirty years of its performance it is clear that Kosi project has been a spectacular success from the point of flood protection. But it has not been welcome for irrigation purpose.

Many different diagnoses have been made explaining the poor performance of the canal irrigation systems. But one important reason never features in such literature. In a region where there is little need of irrigation, irrigation projects can never find good reception. Thus, in all the canal command areas in North Bihar the cultivators have shown great reluctance to construct field channels to receive water. The task, originally entrusted to the beneficiaries, has now been taken up by the irrigation authority. In South Bihar, in sharp contrast to this reluctance, the cultivators themselves take up

initiatives to dig out channels as long as 3 kms. in the hope of receiving canal water /‾Pandey and Muthana, 1980: 13_/. Every year the local dailies carry a couple of reports about a memorandum submitted by the villagers, or a demonstration, even some hunger strikes, all in demand of irrigation facilities. But all those are from South Bihar, I have not come across any such report from North Bihar. It is certainly true that much of the failure of canal systems is because of wrong alignments or bad administration. But there is still a fundamental question are these really worth improving when the very purpose of the projects are questionable. Are not the irrigation projects unnecessary for most parts of North Bihar?

But irrigation plan in Bihar has not been made with any such consideration about the environment and agricultural requirement. The engineering possibilities alone determine the nature and type of extension. The State Irrigation Commission had estimated /‾India, 1972: 66_/ the potential irrigation capacities from surface water sources in different regions (Table - 3). North Bihar plains, understandably, is the ideal ground for such engineering feat and 53 per cent of such potential was identified in this part. The rugged terrain of Chotanagpur and Santhal Parganas provide, as is expected, the least opportunity for such engineering games. The Commission makes no adjustments for the requirements of the regions. The irrigation landscape in Bihar is changing therefore, but not necessarily for the betterment of agriculture and population.

Table - 4 shows the distribution of net irrigated area, by sources, between regions in Bihar. If we remember that the old Sone canal system accounts for the major part of canal irrigation is South Bihar we get an idea of the nature of extension works in the post-independence period. The most deserving area, South Bihar, still has two-third of all irrigation facilities in the State. But current emphasis on surface water utilisation has been the same for both North

and South Bihar. And Chotanagpur is totally neglected. Besides, the data shows only utilisation, the potentials created is much higher and underutilisation of the potential is a far more serious problem for projects located in North Bihar. In South Bihar, with a history of irrigation, the net increase is only marginal since many extension programmes actually replace an already existing method. In North Bihar, the increase is real. We should also add that the data here pertains to 1970-71. Changes since then have been more in conformation of the type we are indicating.

There are of course, economists, who do not understand diversity and equate it with disparity. The nature of extension will certainly impress them, provided, they do not look also towards Chotanagpur and Santhal Parganas. Indeed, such arguments in favour of extension of irrigation facilities in North Bihar is sometimes given and therefore, need discussion. If the traditional distribution of such facilities between North and South Bihar shows regional disparity how does one compare the European countries which rarely have any irrigation facility? Why should one look at it so mechanically and fail to acknowledge the specific necessities of different environmental conditions? For North Bihar far less care has been taken to look after its real necessity - the problem of drainage. The Kosi project is successful as a flood control project save for the widespread waterlogging of areas because of non-utilisation of irrigation supplies. Irrigation was only a later addition to the purpose of the project under the auspices of the World Bank. Even the National Irrigation Commission, which rarely shows deep insight could not but note [India, 1972:74] that the serious problem of drainage in Gandak command area had practically received no attention. By a recent estimate [Joshi and Agnihotri, 1984: 531] the waterlogging and salinity cost to society from Gandak Project is as high as 180.4 crores of rupees. But everywhere in North Bihar, as a contribution of the irrigation projects, waterlogging has become very widespread. The recurrence of flood in the more recent period, is also worth noting. In all the flood protection

schemes around Ganga embankments and river beds are rising from year to year. It may be recalled that during the colonial rule the damages of putting up of embankments as flood protection measures on delta building rivers like Ganga or its northern tributaries, were repeatedly pointed out. But the same method is applied today with increased vigour. In consequence, the river beds in the embanked rivers rise with deposits and every second or third year the embankments collapse requiring re-construction. But then, there are contractors who gain a lot from such recurring expenditure.

Extension of minor irrigation facilities has become almost synonymous with extension of tubewells. Along with the canals tubewells, energised or not, have spread rapidly. For ground-water appropriation tubewells are undoubtedly more efficient than the traditional wells. But in absence of alternative scope of labour-time disposition the increased efficiency need not be desirable [see Whitcombe,1971: 80] those help only the rich. Particular mention may be made of the 'inter-mediate technology', the bamboo-boring methods which have been discovered locally [Appu,1974]. As a cost saving device but still suitable for the characteristic physiographic zone the bamboo tubewells bring benefits of tubewell irrigation even to the poors. But it should also be added that sometimes tubewells are desired for a very different reason. Those can be individually owned and operated and in many a case the difficulties of social management (either bureaucratic or communal) of irrigation have resulted in the expansion of tubewell irrigation. A study undertaken in Sone Command Area report [Pandey and Muthana, 1980:48] that even in canal-served villages people show preference for electric pumps 'because of its versatile use and convenient self management'. In one village studied good number of cultivators have gone in for electric pumps in spite of the existence of the canal there. As we have already discussed, the convenience of self management has helped extension of pumpsets even in ahar-pyne irrigated villages. Unlike canals, in these villages however, the

pumpsets threaten to destroy the communal works thus effectively reducing the total area irrigated.

And yet in cases of North and South Bihar plains the regions have either been dumped with unnecessary resources or experienced a replacement of one mode of irrigation by another. For Chotanagpur and Santhal Parganas the irrigation policy has created havoc. The terrain condition here is generally unsuitable for extension of canal irrigation. But there is no dearth of river valley projects. Beginning with the Damodar Valley project immediately after independence one after another, almost all the major rivers of Chotanagpur and Santhal Parganas have already been harnessed. But the command area of Damodar Project irrigation lies in West Bengal; the same is true for other rivers. Chotanagpur has only the reservoirs.

But why is it so that the harnessing of these rivers are not done in the plains where the benefits accrue? This is because these projects are multipurpose, and one of the purpose, that of power generation, overrides others. For generation of power it is necessary to locate the dams and reservoirs at high altitude. While the hydro-electricity generated benefits the industries and rural electrification remains dismally low for this region [Sengupta, 1982: 19] large chunks of land are acquired for the reservoirs uprooting lakhs of people and submerging thousands of acres of agricultural land. The Koel Karo river valley project which is in progress at present, comprises of two big dams and four power stations. The project threatens to destroy 200 villages and submerge 45,000 acres of agricultural land. Similarly Subarnarekha project is likely to affect 150 villages and about one lakh people.

We should note that this problem confronts the 'tribal' people in all parts of India, in fact all over the world [e.g. Barabas and Bartolome, 1973: Aspelin and dos Santos, 1981] and the severity of the problem has drawn much attention in concerned sections. Kashyap Mankodi and Tanushree Gangopadhyay

rightly designated these areas as 'obey' areas as against the 'command' areas [cited in Dogra, 1984: 74]. Not only are these upland people ruined for the present, their future development comes also at stake. The water of these uplands are already being committed to the lower levels. If in a future date they are eager to appropriate those for their own benefits that would be impossible [Jones, 1976]. Much attention has been given to international and interstate water sharing. The dispute between Bangladesh and India over sharing of Ganga water or that between Karnataka and Tamilnadu for Cauvery water supply are dealt with due seriousness. But Chotanagpur and Santhal Parganas is not a state, although the people here are waging struggle to acquire statehood. But till they succeed others have legitimate rights to disburse away natural resources of this region.

Even if the projects are able to irrigate parts of Chotanagpur, the problem is still the same. Because of the undulated terrain small patches of lowland are irrigable by canal water, particularly from the small projects. But such irrigable patches, if not located in West Bengal or Bihar are certainly far away from the reservoir sites. The erstwhile population of the acquired land are still the loosers - they receive no benefit of irrigation. As the table -4 shows tubewells are also rare in this region. The rocky country does not provide good prospect of boring. The traditional methods are the only ones possible. But social irrigation works like bandhs are not a favourite of the responsible departments while the land acquisition problem makes it almost impossible for the people to undertake the task by themselves after the pradhani system is abolished. Wells, since those are privately managed, are encouraged. But here, a substantial proportion of initial work is abandoned since the digging is often obstructed by subsoil boulders. A probable solution is the construction of big diameter wells like those in Peninsular India - as I was told by someone. It is not possible for me to assert its feasibility. But the

suggestion may be worth exploring since big-diameter wells are favoured for some reason, by the people in the granite country of South India.

This is the irrigation picture of almost a half of Bihar - Chotanagpur and Santhal Parganas. Its traditional systems have collapsed, alternatives have not spread. But irrigation needs of other areas are being met by uprooting the people from the villages in this region. The picture is not complete if we do not discuss the popular reaction. As against passive reluctance found in North Bihar, in Chotanagpur and Santhal Parganas the people have come actively to resist river valley projects. Arun Sinha [1982: 127-28] reported for around 1980 that construction works on two major projects, Subarnarkeha and Koel-Karo, were being resisted by massive agitations. The work schedule for three reservoir schemes in Ranchi district, four reservoir schemes in Singhbhum district and two such schemes in Santhal Parganas were affected due to public objections. The people refused to accept compensation for another reservoir scheme in Ranchi district. In two years alone, 1978 and 1979, at least twenty people died in police firing at project sites. At some dam sites the work was in progress with armed forces in station. And, thus with police protection 'development' has finally come to Chotanagpur!

Chapter IV

INDIGENOUS MANAGEMENT

More than those of the administrators and field level observers, the views of some of the grand theorists are better known in this area. In the 'fifties an orientalist named Karl Wittfogel [1957] made a sweeping generalisation about the management of hydraulic works and earned a lot of fame by using the theory for denigrating socialist state systems. Essentially all these grand theories which culminated in Wittfogal's attempt, reflected the simplistic belief that a bureaucracy is necessary for undertaking such work. Since then the thesis has been successfully challenged by many writers but generally on the ground that traditional irrigation works were rarely major works requiring bureaucratic management. A suggestion that traditionally the people themselves managed these works is implicit in the criticisms. But little work has been done about the details of local level or popular management of the indigenous irrigation works.

There are some exceptions, but rarely the government officials undertake every bit of management works or are able to perform it successfully, in any irrigation works, traditional or modern. At some level the responsibilities ultimately pass away to the beneficiaries. Whenever there are many beneficiaries it is unlikely that only one of them will undertake all such tasks. Some of them at least should combine to undertake tasks which may range from financial to physical participation. Earlier I have referred to some cases of large-scale community participation in management of irrigation works. Others too [e.g.Chambers, 1977 :340-363; MIDS, 1983: 114-129] have drawn attention to such features for South India. Dearth of information restricts the scope of generalisation. Yet, on the ground that the irrigation bureaucracy rarely have the time and efficiency to respond to every bit of necessity in the vast area under their domains, one may not be very wrong by suggesting that some community functions still exist in great majority of irrigation works.

But it is very difficult to get any reliable information about these community works. This is because the theories about their functioning are rarely scrutinised in practical fields. As long as the works remain out of the purview of the bureaucracy such explanations are only of theoretical interest and judged by theoretical consistency than reality. Explanations about community labour (goam, kudimarammath) are in plenty. But curiously, those need for their acceptance, accordance with the existing notions of rural power structures rather than substantive information about irrigation organisation. A common trend is to declare flatly that the powerful landlords or the village panchayats undertake the task. It will seem to be a sufficient explanation. But intensive inquiry may reveal that many other villagers who are not under the control of the landlords still join in goam, that panchayats or landlords' domination fail to motivate the villagers for any other community works or that even contesting landlords join hands for such works [eg. Lewis in Marriot, 1962]. On the other pole there are temptation to such idealised generalisation as that every member participates in the community action, that such actions override all types of differences. In fact irresponsible and bad quality of reporting make it doubly difficult to make even an attempt for detailed studies of such organisations since a number of 'authentic' reports can be always cited discouraging further inquiry. But we have already noted a case to show how grossly wrong may be even 'highly authentic' information in this particular area; we have in mind the expert committee opinion as that there is little 'tank' irrigation in Bihar. If such gross misreporting may occur even for as concrete objects as physical structures it should not be too much to grant that misreporting is rampant in non-material aspects like work organisations.

However, there is a good sign. From a recent interest in management of irrigation works some intensive inquiries have been conducted lately. These at least bring out the vast complexities of the local management methods as well as great interecacies of some of them. It is amply clear that any attempt at generalisation

at this stage is sure to be wrong. Therefore, I shall present here, as a summary of the studies, the typology of irrigation organisations as in my appreciation. Later I shall discuss one of the most intricate type of organisation to show its potential to modern management principles.

Communities may materialise on the basis of any one of the three factors:

(i) Personality: by his dominance a landlord or by his charisma a local leader or even an irrigation administrator may bring people together for some community work, be it for manual or financial cooperation. The surety of participation may be increased by legal compulsion or, if time permits, by establishment of it as a custom. But still, it is unlikely to have much vitality. If the participants experience discrimination in the distribution of benefits from the community works they are likely to be reluctant and abstain at every opportune moment.

(ii) Distribution: If the benefits are distributed in such manners that the participants do not feel any discrimination the community is likely to have more vitality. Many different arrangements have been noted for effecting such distributions. Sometimes the community employs people other than the beneficiaries - landless backward castes or scheduled castes, to distribute water, This system has been noted in many different places in South India. Sometimes the physical structures for distribution are thoroughly regulated towards this end. Rotational supply of water or supply beginning from the tails of water-courses are also among the methods noted for the same purpose. But here too difficulties may arise in course of time. Common distributors may be influenced by threat or bribe; the physical structures may be tampered with.

(iii) Property based: A third variant may be based on property distribution making it impossible for some to even effect inequitable distribution of water. This need not be necessarily collective farming; we shall discuss another variant in this section.

The three types do not describe merely three different degrees of strength of the communities, those also correspond to decreasing obviousness. Thus intensive studies too overlook the more profound characteristics. In a distribution based organisation there may still remain charismatic personalities or powerful landlords and the researcher may stop merely at that thinking it a sufficient explanation, without ever feeling any necessity to go into the distribution or property questions. This type of ignorance and misreporting may be extensive even for the well-studied organisations like in south India or for some canal command areas.[14] Besides, the reasons also help to delineate the exact boundaries of the communities. It is rather obvious that everyone in the village, or among the landowners may not have the same satisfaction and therefore may abstain from community works for irrigation. The tasks undertaken by the community may range from field level allocation alone to maintenance and even construction. But that should depend on the vitality and the capability of each such community and need to be explained from the structure of these communities.

I studied intensively one unit of an indigenous work in Bihar, an ahar-pyne system. I shall describe here[15] some elements of local management as observed there, just to bring out the novelty but refraining strictly from generalization. Indeed, the observations, though on a traditional system, was contemporary. And we cannot even claim that this was the traditional method of management except the indirect suggestions that there is nothing to prevent its occuring at a very remote period. The ahar-pyne area has some interesting features. In absence of an alternative, either in source of irrigation or altogether to agriculture, the peasants need to maintain the traditional sources. The complete indifference of the government to this system practically compell the peasants to secure local management. This may explain the occurrence of some of the surprising features observed in the landholding pattern in that area. The shear necessity of securing communal management must have forced the beneficiaries to reproduce the necessary social concomittants.

The system inquired consisted of a 30-kms long diversion channels(pyne) from a seasonal river feeding as many as 19 ahars. Community management would be necessary at many different levels of such a system. So the first task was to identify the primary units of such communities and then study those and their combinatorial principles. The ahars had one or more distributories from which separate ayacuts benefitted. The beneficiaries of each such ayacut, ranging in number between 20 to 100, formed the primary level of community. To my great surprise I noticed that the landowners in the ayacut have their lands located in a peculiar fashion. Their total holdings are fragmented and everyone has some plot at the head, some others at the middle and some more at the tail of the distributary. The implication must be pretty clear - everyone has interest in irrigation of all parts of the ayacut and if only a part can be irrigated because of water shortage then none of them escapes deprivation. In addition they were also close neighbours though did not belong to a single caste.

Add to this the fact that crop grown in the ayacut area is paddy, the same for every cultivator. The monsoonal behaviour necessitates sowing immediately after the first heavy shower. Thus all the plots in the ayacut are sown almost on the same date with the same crop. In consequence, all the cultivators in the ayacut require irrigation almost at the same time. Thus formal democracy becomes redundant; any small group of cultivators can reflect properly the irrigation necessities of others. Whether the powerful landlord or panchayat headman is present in such a decision making group is a moot point; the decision to open the distributary outlets are taken informally by a small group. As all the cultivators are close neighbours the decisions are communicated to everyone easily. Because of the characteristic distribution of the plots no one is deprived of water. Thus the decisions about the method of allocation and duration too can be decided informally. And once this 'fair' allocation of water is assured the individual cultivators may have some personal difficulties but do not lack motivation to join in community works for irrigation. In the same informal manner, a small group

can initiate such works for maintenance and even construction. The amount of work undertaken depends on their abilities to mobilise resources. Presently, some initiative is restrained because of expectation of assistance from external agencies like the government and reduced interest of some who have acquired pumpsets. But the extent of work undertaken is determined circumstantially, the structure of the local organisation is such that it can take up all tasks: construction, maintenance, allocation and conflict resolution among its member.

The notable feature of this property-based organisation is that it has little formal structure. Being asked whether there is any irrigation organisation, the villagers flatly refused the existence of any such thing. But then, I got quite intrigued how such a vast network of irrigation can still survive so well without any care from anyone. The villagers are not even aware of the characteristic landholding pattern in the ayacut. The ayacut had emerged after zamindari abolition with a very different pattern of holding. But over the years such adjustments have taken place. Instead of this being a conscious process it is more likely that those ayacuts where the subconcious process did not lead to such distribution were ultimately ruined of their community organisation and ahar irrigation facilities. We had purposively selected one unit which is still functioning. The adjustments of residential locations too have occurred in the same subconscious manner. The handful of landowners of this ayacut who were residents of other localities often found themselves unaware of the dates when ayacut were irrigated. Over time they have either moved into the same residential locality with others or have relinquished their ownership of the plots in the same ayacut.

Several ayacuts benefit from the same ahar and several ahars are fed from the same pyne. There are some such works where many of these primary (ayacut level) communities need to combine for irrigation works. But before we enter into the discussion of

the higher level organisations let us make a brief observation about the possible generality of the features noted for the primary level organisation. Land is privately owned, and it is not a collective. But the fragmentation and locational peculiarities make distribution of irrigation water 'equitable'. The peculiar holding pattern as that every cultivator owns a fragment of upper, middle and lower levels of the ayacut have also been noted for irrigation systems in Sri Lanka /Leach,1961/ and Philippines /Coward,1979: Siy,1984/. In fact such portfolio holdings of all varieties of property might have been quite extensive. Students of European history know that fragmentation was widespread in large parts of Europe for several centuries in the past. Well, the European peasants too did not escape the jeer of the modernists. The extensive and long lasting phenomenon was explained away lightly as the outcomes of hereditary division of property and were regarded as evidence of peasants' irrationality. Only recently some studies are trying to revise the appreciation. In the villages in Bihar where I had conducted my intensive study the government has begun consolidation operation to open up the scope of 'development'. The 'irrational' villagers are engaged in retaining their fragmented holdings even by bribing the survey officials. In the high offices some are disgusted with yet another evidence of foolhardiness of peasants and power game by vested interests in the villages which defeat all developmental efforts.

The similarity in crop selection and crop practice is a feature which rather appears as an obvious necessity. May be there are very few reports because of the obviousness. Instead, observers /e.g. Tantigate,1979; Jayaraman,1981/ have noted that conflicts occurred over irrigation time and productivity decreased in consequence when different crops were cultivated along the same ditches even in modern canal systems. In fact this may be a very important reason why innovations are often refused by the cultivators in irrigated regions which has created much headache among the experts. They often feel that the great potential of irrigation facilities which could have been realised by

revolutionising cropping patterns remain untapped because of lack of response from the irrigators. Much of it may be because of a wrong strategy of expecting individual adopters of innovation; the system necessitates the treatment of the whole community as one unit. It appears that in some of the traditional system it was a customary practice to take approval of all members of irrigation organisation while introducing a new crop [e.g. Hutapea et.al., 1979; 169]. The traditional irrigation organisations are not stagnant by nature, as is often given to believe Their failure to develop further is more because of unsuitable developmental strategies.

The cultivators change their practice almost year to year responding to the availability of irrigation water for that year. Even if there is shortage of water supply in one year the flexible practices may still help them to get a reasonable output. But they are able to make such alteration only when enough time is available for doing so. In many traditional systems this initiative of the peasants were internalised by providing captive reservoirs (like eries from system tanks) to villages. The villagers knew a few weeks in advance the resources certainly available to them. Many writers [e.g. Tamaki, 1977: 23-24; Downs and Mountstephens cited in Coward, 1977: 231] have suggested that large-scale systems be designed so as to create smaller sub-units relatively independent of the total system. Socialist China has extended such designs (called 'melons-on-a-vine' design) in a systematic manner. Modern canal irrigation in India however, substitutes such design by notifying the dates of release of water. The dates rarely correspond to the requirements, the availability of water is also insufficient. In any case the certainty is far less than what would have been if the cultivators themselves had distributed the same amount of water through captive ahars. Correspondingly they get far less scope to alter their cropping and irrigation practice to suit the availability of water.

We may now turn our attention to the upper level organisation and the government. For certain other works several such primary communities joined their hands. There were incidents when thousands of people participated together. But the combinatorial principle for making even such groups were quite simple. The location of each work automatically define the potential participants. No primary community has any interest in maintenance of the physical structure lower down the point in the system from where it receives its supply. But towards the upper reaches, it has interest in proper maintenance of the supply lines all throughout up to the point of origin of the supply channel(pyne) which may be several kilometres upstream in the system. Normally the sections between the outlets in the system are divided between communities and no primary community have any need to maintain the part of the common supply channel beyond the point from where another primary community receives its supply. But there are certain works when the resource of the immediate primary community is not enough. In such circumstances they try to raise additional resources from other primary communities lower down the channel system who too have interest in the maintenance of that part of the system. The community nearest to the point where the work is needed try to undertake the work by themselves. If it is beyond their own capacity they send messangers downstream requesting for help. Since the others too fully understand the consequences, helps are received almost with certainty.

This may help us to understand the proper role of the authority - the government or an overlord. The necessity of help from such an authority arises only for those works which need substantial resources, as high as are beyond the means of the communities. These are the construction of weirs on the rivers, costly renovation of major regulation works etc. A Grand Anicut might not have been constructed without the active help of an authority. But apart from this the proper contribution of an authority in the engineering matters is limited.

But an authority must play a far more important role in social matters facilitating community action. It may encourage people by methods like tax remission, to construct new irrigation systems. In particular, it should have proper legislations recognising the rights of the communities failing which the community actions suffer. The neighbouring primary communities do not only co-operate; they also come into conflicts when one tries to appropriate more water depriving others. Very often this results into physical clashes. Sometimes the clashes, which start between the neighbouring communities receive further re-inforcement from the beneficiaries lower down in each section of the system. Every year, several such clashes occur in South Bihar. In the particular unit studied by me there were several serious riots in last fifty years resulting in some deaths. The internal conflicts between the members of a primary community may be resolved within itself. But those between the communities cannot be resolved in the same way. An authority, who may act as a mediator, may be of great help in reducing such conflicts. Zamindars in this area recognised the customary rights of each community over the water flowing through their channel. In the particular area I studied the old zamindar had a book, called Lal Bahi (red book) entering the records of rights of each village. In case of dispute, the parties could quickly settle it in the court of the zamindars. Today, civil suits on such disputes continue for decades; there is no record of right to help settlement in the question; even if the precendence is entered sometimes in the proceedings the ownership of the communities cannot be upheld by the judiciary of a political system recognising only private property.

It should be sufficient as an introduction to the traditional management pattern. No doubt, the discussion raises many other questions. But we have to keep aside those for the sake of brevity. In any case the introduction must confirm the point made by Coward [1977] that the guidelines for solution of many different management problems related to irrigation may be obtained from

the functioning of the indigenous management methods found all over the world. It should not be overlooked that the study is important even for the management of modern irrigation works. Such questions as how to form water-users' associations, what should be the properdivision of responsibilities between the irrigation bureaucracy and the beneficiaries, how to introduce agricultural development programmes etc. have baffled the concerned experts even in modern irrigation projects. Guidelines for such works can certainly be obtained by studying the functioning of well-maintained indigenous irrigation systems. Interest in this area has grown only recently. One may hope for a better appreciation in a not-too-distant future.

V

CONÇLUSION

Irrigation, or for that matter any branch of scientific knowledge, cannot be seen as traditional and modern. Modern knowledge should develop on the basis of the old and that is where the opportunity was missed in ex-colonial countries like India. In Japan or in China there was no such big gulf between the old and the new and they could successfully utilise the past developments over thousands of years for further progress. In countries like ours, whose colonial heritage has led only to the disrespect and ignorance of the past, even the indentification of the traditional works become difficult. Far less is known about more intricate aspects like the efficient but less attractive technology or traditional methods of management. Detailed knowledge of these aspects is the prime necessity. Much can be expected from the rising Peoples' Science movements in the country, for there are some among them who are interested also to learn from and not merely teach the people. The success of such movements can eliminate much of the oppressive effects of colonial heritage and west-centric modernisation. The solutions to many of the current problems lie in the success of these movements. We have already seen that such knowledge may help us in greatly improving the performance of the existing irrigation systems, both traditional and modern.

For new constructions radical departure from the existing approach is necessary. The modern designs for major irrigation projects start from the possibilities at the intake points from rivers etc. But as Tamaki [1977] indicated, historically, development of irrigation works has occurred in an inverse manner-from small local systems gradually reaching to interconnected systems in course of search for further water supply (or water control). The former is the top-down approach and in this the central authority predominates. The latter is the bottom-up approach in which peoples' participation is ensured and consequently, better management of water and environmental interaction.

The government or a central authority can still provide excellent help in construction by openning up new sources of water supply. Those broad-range systems are often great engineering challenges and modern engineering techniques may open up great potentials. But from the point of view of irrigation these broad-range systems are only secondary, useful only when there are local users with sufficient capabilities to utilise the created opportunity. In this perspective a famous Japanese Professor, Akira Tamaki [1977] has pointed out what has fundamentally gone wrong with the modern irrigation development programmes. In Official documents regarding irrigation it is difficult to find a description, let alone analyses, of the human side of organisation and operation of the system. All that gets emphasise is the engineering aspects. In order to rectify the sad state of affairs it is essential to understand that the local terminal system is indeed the main system. It is the foundation of the entire network. The broad range systems, in spite of all their technological challenges, gigantic sizes and involvement of the central authority are indeed, the 'sub-systems'. Those should be developed therefore as 'sub systems', not to initiate a whole irrigation system. The performance of the irrigation projects in India confirm the diagnosis. There were developments like that of the Grand Anicut on Cauvery by Arthur Cotton or the renovation of inundation canals in Sind where engineering works were confined to the broad-range systems alone and provided supply to the existing local networks. Those were the most successful ones in modern engineering. In contrast, those canal projects which replaced the traditional well irrigation methods or overlooked the importance given locally to control of salinity, waterlogging and floods, met with failures. Further extension must bear this in mind. With the great potential of modern engineering it may provide additional supply to 'tanks', it should think of recycling groundwater along with intensive utilisation, it is able to provide better protection against flood and waterlogging. There is still ample scope of engineering works. But it is time to understand that meeting

engineering challenge is not the primary task of irrigation planning. The rising concern of the people to the blunderous designs of many modern irrigation projects may in due future enforce radical change in irrigation planning with primary emphasis given on human aspects.

The misplaced engineering workmanship has already produced some serious problems in salinity, waterlogging, flood recurrence, extensive underutilisation of irrigation potential etc. etc. It is a big question what will happen to these systems. Some of them are in such state of initiation, in spite of huge expenditure incurred, that those may still be summarily closed down for a better financial result. But some others are well-entrenched and cannot be closed down. For such systems it is probably time to accept that the environment has been changed and plan accordingly for betterment of the situation. The present approach is to seek engineering solutions to salinity and waterlogging and administriative solution for underutilisation of potential created. Thus, even in the remedial approach no reliance is placed on the local people. Close observation in these areas may reveal that the people have already accepted the change in environment as a fact and are engaged in developing survival strategies suitable under the new situation. After all people have survived in marshy and waterlogged areas, in flood prone countries, almost in every type of situation. It is most unlikely that they have just washed their hands of these 'wasted' millions of acres. But they are doing it without any support from the government. Should they succeed, the performance of many of these disastrous extension projects will improve from the present miserable state, although it is highly unlikely that the pre-extension prosperity would ever return to these tracts. But even then, the recoupment made by popular imagination may be cited as the evidence of long-run success of the present approach and may make strong case for repeatation of the same mistakes in extension. I guess, this is how some of the most notorious irrigation projects undertaken during the last century have made better results in the

more recent period. And I am afraid that the policy is not going to change in near future; the central authority will go on creating its engineering monuments and force the people to make necessary adjustments to justify its misdeeds. Yes, it is high time to rise up to the contingency and include, in our irrigation policy strategies for agricultural development of saline and waterlogged areas. That is the best way to cope with the man-made disaster. But equal stress is needed to avoid treating this as yet another piecemeal strategy without any fundamental change in the total policy, without eliminating the basic reason which lead to the occurrence of such disasters.

Table-1

Distribution of Irrigated Area in The World, 1952 and 1972

Sl. no.	Country/ Region	irrigated area, in mill.hectares 1952	1972
(1)	(2)	(3)	(4)
	South, South-east and East Asia		
1.	China	40.0 (34.16)	74.0 (36.78)
2.	India	19.7 (16.82)	32.7 (16.25)
3.	Pakistan	12.1 (10.33)	12.0 (5.96)
4.	rest of the countries	7.4 (6.32)	13.3 (6.61)
	Total	79.2 (67.63)	132.0 (65.60)
5.	U.S.S.R.	6.0 (5.12)	10.4 (5.17)
6.	West Asia	6.5 (5.55)	10.9 (5.42)
7.	U.S.A.	10.7 (9.14)	16.9 (8.40)
	Africa		
8.	Egypt	2.5 (2.13)	3.0 (1.49)
9.	rest	1.7 (1.45)	3.6 (1.79)
	Europe excl.U.S.S.R.		
10.	Mediterrenean countries	5.4 (4.61)	9.3 (4.62)
11.	rest	0.7 (0.60)	3.7 (1.84)
	America excl. U.S.A.		
12.	Mexico	1.7 (1.45)	4.0 (1.99)
13.	rest	2.1 (1.79)	6.0 (2.98)
	Australia and Newzealand		
14.	total	0.6 (0.51)	1.4 (0.69)
	TOTAL	117.1 (100.00)	201.2 (100.00)

Source: Stern [1979: 16-18] compiled from Annual Bulletins of International Commission for Irrigation and Drainage, also see Framji and Mahajan [1969].

Table - 2

AREA IRRIGATED BY ALL SOURCES : BIHAR

District	area irrigated as percentages of cropped area*	
	1931	1971
(1)	(2)	(3)
NORTH BIHAR:		
Purnea	1.53	8.61
Saharsa	n.a**	12.25
Darbhanga	5.81	8.65
Champaran	7.35	18.11
Muzaffarpur	8.59	5.65
Saran	15.62	25.42
SOUTH BIHAR:		
Shahabad	40.25	64.41
Patna	55.25	58.59
Gaya	48.87	59.37
Monghyr δ	18.77	16.11
Bhagalpur	n.a**	34.39
CHOTANAGPUR AND S.P:		
Palamau	11.59	16.02
Santhal Parganas	17.33	3.64
Singhbhum	14.75	3.87
Hazaribagh	1.43	2.09
Ranchi	0.19	2.15
Dhanbad	n.a**	2.06
TOTAL BIHAR	17.92	19.55

Source: (i) for 1931 the Tables AS-IV, District Census Handbook, 1961 Census, each district,
(ii) for 1971 data, Agriculture Census, 1971

* As per data availability, the 1931 data is for percentage of gross irrigated area to gross cropped area and that of 1971 is percentage of irrigated area to net sown area.

** Saharsa and Dhanbad districts were created after independence. In Bhagalpur and Saharasa together (i.e. in old Bhagalpur district) in 1931 the percentage of irrigated area was 17.31

δ Large part of Monghyr district lies in North Bihar.

Table - 3

Estimate of Potential Irrigation Capacities From Surface Water Sources, Bihar

region	potential irrigation capacity	geographical area as percentage of total state
(1)	(2)	(3)
North Bihar	3.1 mill. hect.	29.6
South Bihar	1.7 " "	24.6
Chotanagpur and S.P.	1.0 " "	45.9
State total	5.8 " "	100.0

Table - 4

Distribution of Net Irrigated Area By Different Sources Bihar, 1970-71

Sl. No.	Source of irrigation	p.c. of irrigated area lying in North Bihar	South Bihar	Chotanagpur and S.P.	total
(1)	(2)	(3)	(4)	(5)	(6)
MODERN TECHNIQUES					
1.	government canals	25.95	69.83	4.22	100.0
2.	tubewells	34.33	64.82	0.85	100.0
TRADITIONAL TECHNIQUES:					
3.	wells	45.77	38.86	15.37	100.0
4.	tanks, private canals and other sources	11.65	72.15	16.20	100.0
TOTAL(from all sources)		23.78	67.19	9.03	100.0

Source: Compiled from Season and Crop Reports, Bihar, 1970-71

NOTES:

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1. Nor did the indigenous technologies of European peasantry always received due appreciation from the 'Scientific community There too, some of the recent researches are rediscovering the rationalities behind some old practices.

2. For example, only about 30 per cent of irrigation potential created in U.S.A. is actually utilised. In the 'fifties the continuous increase in height of the river beds defying flood control measures was quite commonplace - personal talks with Gilbert Levine and Alice Thorner.

3. Compare Cotton's description cited in the text with the following by P.N.Haksar and other [Haksar, et.al., 1981: 9]:

> "....The inculcation of Scientific Temper in our society would result in our people becoming rational and objective,....Scientific Temper cannot flourish in a grossly inegalitarian society where 50 per cent of population lives below the poverty line and almost 70 per cent of our people, especially females are illiterate".

Cotton had no difficulty in acknowledging the scientific importance of the knowledge acquired over generations by the same poor, illiterate folks of a grossly inegalitarian society. And behind the patronising attitude of Haksar et.al what really exists is the contempt of the modern educated elite towards the poor, the illiterate. It is taken for granted that the latter cannot have scientific temper, no matter that they are actual workers in fields, factories and houses.

4. Equal difficulty arises in taxonomy. Almost all the systems combine many different techniques. What is commonly known as surface irrigation also require lifting of various forms. Lift irrigations are often complemented with gravity flow before application of crops.

5. One who had observed this district feature was Voelcker [1893].

6. The root word is possibly 'aur'. 'ar', 'air' are suffixes in rivers and place names frequently found in South India, Chotanagpur as well as in Indonesia. Ahar may be Sanskritised form of 'aur' and though 'aur' is a Tamil word its root may be from some previous language.

7. We are following the old district names. Lately the districts have been re-organised.

8. See f.n. 11.

9. I have described the details elsewhere [Sengupta, 1980:164] The District Gazetteer provides the details of scarcity and famines in each district.

10. The team also noted, "Some irrigation tanks do exist in Bundelkhand area of Uttar Pradesh and undulating terrain of Bihar" [India; 1966: 8]. But parallels drawn with U.P. and Punjab as well as mention of pynes in other sources of irrigation (p 26) indicate that the reference was not about extensive 'ahar-pyne' irrigation in South Bihar plains. Probably the undulated terrain was reference to Chotanagpur and Santhal Parganas.

11. The official statistics in Bihar do not show ahar-pyne irrigation under specific head. We estimated the total area irrigated by all sources excluding government canals, wells and tubewells and compared it with the data available from Survey and Settlement Reports of different districts which show separately private canals (pynes) tanks and ahars and other sources like depressions, rivers, streams or waterfalls.

12. Even in Tamilnadu the official performance is not very satisfactory [see MIDS, 1984].

13. The mention of indigeneous works in the study was only incidental. It is not definite that only those villages for which ahars have been mentioned are the only ones among the sampled villages to have indigenous sources of irrigation.

14. I myself did the same and had stopped at an earlier stage of inquiry thinking that is sufficient [Sengupta, 1980]. Only later, after I came across a writing by Coward [1979] felt the necessity of going into details of field systems and property relations.

15. This is an extremely simplified presentation of the detailed study.

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